repository performance. The Supplement fails to discuss any specific plans or mechanics for fuel blending, and makes no mention of possible impacts of incorrect record keeping.

Response
The processes planned for the blending commercial spent nuclear fuel are the same that are being used successfully for fuel management at nuclear plants through out United States. The considerations mentioned in the comment regarding record keeping are routinely and safely done at the nuclear facilities.

Further information on blending strategy and proposed facilities can be found the Science and Engineering Report (DIRS 153849-DOE 2001).

7 (13514)
Comment - 010367 / 0005
"Blending" of various temperatures is untested, timing and results unknown.

Response
An error during loading of a waste package could occur, and such events could result in excessive temperatures. The possibility of such events has been considered, and it is expected that disposal container loading procedures will be developed based on thermal analyses of the various waste package configurations such that sufficient margin will be available to ensure that temperature criterion will not be violated if a loading error occurred (DIRS 150198-CRWMS M&O 2000). Further information on blending strategy and proposed facilities can be found the Science and Engineering Report (DIRS 153849-DOE 2001).

7.1 Repository Design

7.1 (31)
Comment - 6 comments summarized
Commenters said that the design of the waste package is preliminary and conceptual. Others said the design described in the Draft EIS is no longer the operative design concept and it is likely to change again as more is learned about the materials and their interaction with near-field environmental conditions at selected thermal load conditions. Some noted that the most current design of the waste package has the two layers flipped; the Alloy-22 is now on the outside of the canister with the carbon steel on the inside, and the thicknesses have changed.

Commenters state that because the waste package is so central to repository performance, and to the amplification or attenuation of impacts from the repository, the EIS should contain a complete and final description of the waste package chosen by DOE to ensure waste containment. It would also be appropriate for the EIS to comprehensively evaluate alternative waste package designs and select the preferred design for use in a Yucca Mountain repository. Without a preferred design, it is impossible to evaluate the environmental and human health impacts of the repository.

Commenters were concerned that many aspects of the waste package are conceptual. Examples included statements in Chapter 2 that the waste packages would be loaded with fissile material and neutron absorbers "if needed." Commenters wanted to know when and how these decisions would be made. Others said that DOE could not conduct detailed reliability analyses on a conceptual design for the waste package.

Response
In the Draft EIS, DOE evaluated a preliminary design based on the Viability Assessment of a Repository at Yucca Mountain (DIRS 101779-DOE 1998) that focused on the amount of spent nuclear fuel (and associated thermal output) that DOE would emplace per unit area of the repository (called areal mass loading). Areal mass loading was represented for analytical purposes in the Draft EIS by three thermal load scenarios: a high thermal load of 85 metric tons of heavy metal (MTHM) per acre, an intermediate thermal load of 60 MTHM per acre, and a low thermal load of 25 MTHM per acre. These scenarios were not intended to place a limit on the choices among alternative designs because, as stated in the Draft EIS, DOE expected the repository design to continue to evolve in response to ongoing site characterization and design-related evaluations. Rather, DOE selected these analytical scenarios to represent the

range of foreseeable design features and operating modes, and to ensure that it considered the associated range of potential environmental impacts.

Since issuing the Draft EIS, DOE has continued to evaluate design features and operating modes that would reduce uncertainties or improve long-term repository performance, and improve operational safety and efficiency. The result of the design evolution process was the development of the flexible design. This design focuses on controlling the temperature of the rock between the waste emplacement drifts (as opposed to areal mass loading), but the basic elements of the Proposed Action to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain remain unchanged. DOE evaluated the flexible design in a Supplement to the Draft EIS, which was released for public review and comment in May 2001.

As described in the Supplement to the Draft EIS, DOE has redesigned the waste package to include a thick outer shell of a corrosion-resistant high-nickel alloy (Alloy-22) and a thick inner shell of stainless steel for strength. This newer design would resist corrosion far better than the design described in the Draft EIS, and has improved the predicted performance of the repository and reduced uncertainties associated with that performance. Section 2.1.2.2.4 of the Final EIS describes the flexible design waste package.

The type and amount of neutron absorber necessary for a specific waste package design would be determined by DOE prior to receipt of a license from the Nuclear Regulatory Commission to receive and posses spent nuclear fuel and high-level radioactive waste. This would have to be done consistent with a criticality analysis methodology that had been accepted by the Nuclear Regulatory Commission. The specifics of that methodology are presented in "Disposal Criticality Analysis Methodology Topical Report" (DIRS 101095-CRWMS M&O 1998), which DOE submitted to the Nuclear Regulatory Commission in January 1999.

DOE has determined how many waste packages with neutron absorbers would be necessary for the alternatives evaluated. DOE accounted for different types and quantities of neutron absorbers in the "baseline" design for the Draft EIS (see Appendix I) to determine the quantity of toxic materials originating from the waste package materials. The updated flexible design did not affect this baseline. The presence of neutron absorbers would not affect degradation behavior of the waste packages.

The Final EIS addresses all aspects of the Proposed Action, including the flexible design. DOE acknowledges in the EIS that the flexible design could be further modified or refined during the license application process, if the site is approved for development. DOE believes that the information on the potential environmental impacts that could result from either the Proposed Action or the No-Action Alternative complies with the Nuclear Waste Policy Act requirements for a Final EIS to accompany any recommendation by the Secretary of Energy to the President to approve Yucca Mountain for development as a repository. This belief is based on the level of information and analysis, the analytical methods and approaches used to represent conservatively the reasonably foreseeable impacts that could occur, and the use of bounding assumptions where information is incomplete or unavailable or where uncertainties exist.

7.1 (33)
Comment - 10 comments summarized
Commenters said that storage casks at some commercial reactor sites have prematurely failed. Problems experienced with storage casks such as the Ventilated Storage Cask, Model 24 system used at the Palisades site and the Transtor system used at the Trojan site suggest that problems with waste package at the repository are inevitable. Commenters stated that the cask design for Plant Hatch is flawed; the process used to design and certify cask designs is not standard, promotes using cheap materials, allows easy changes to designs; and cask design and operations are not tested correctly, vent holes are too small, coatings create flammable hydrogen, ground down welds are too thin, designs are changed for every reactor site, and coatings are painted on rather than baked on, causing turbidity problems in pools.

Response
The issues noted by the commenters are widely documented in bulletins of the Nuclear Regulatory Commission, inspection reports, letters, and other public documents. Many of these issues resulted from a failure of the licensee to adequately implement the required quality assurance and quality control programs; however, they are important because lessons were learned that can be applied to existing and future storage system technologies.

Spent nuclear fuel storage systems, like the one used at Palisades, are designed and licensed to the requirements of 10 CFR Part 72; spent nuclear fuel transportation systems are designed to the requirements of 10 CFR Part 71; and disposal systems are designed to the requirements of 10 CFR Part 60. The storage systems designed only to 10 CFR Part 72, like the Model 24, would not be used for transportation or disposal. As discussed in this EIS, the spent nuclear fuel located at the 72 commercial and 5 DOE sites would be transported to the repository in casks licensed to the requirements in 10 CFR Part 71.

DOE acknowledges the difficulties in design and implementation of effective quality assurance programs. However, much has been learned over the past decades related to fabrication, installation, and maintenance of components important to nuclear safety. As part of the waste package performance analysis, DOE conducted a comprehensive evaluation of fabrication processes that indicated that, for the current design and with a strong quality assurance program, the Department anticipates only a small number of early failures. The updated analysis in the Final EIS projects the very unlikely event of between zero and five packages failing due to manufacturing defects. A strong quality assurance program would ensure proper fabrication, stress relief, and testing of the waste packages before emplacement.

7.1 (191)
Comment - 20 comments summarized
Commenters stated they were not convinced that the technology exists to design and fabricate a waste package that would last for thousands of years. Others were not convinced that DOE has the ability to confidently predict the performance of waste casks far into the future. Some said that the waste casks must last for 10,000 to 250,000 years without leaking and that this was impossible. Others said that the casks would deteriorate after 100 years. Some noted that the EIS even admits that some waste casks would fail within the next thousand years; after 10,000 years all the canisters may degrade and release radioactivity into the water and air. Still others wanted to know how DOE could conclude that the waste packages would last so long when the design of these packages has yet to be finalized, and could still change substantially during the licensing process. Some said that up to 95 percent of waste containment may be achieved with the waste package, yet very little information about its long-term performance capabilities has been developed, including the testing of full size waste packages for extended periods of time and to the point of failure.

Response
The waste packages and waste handling facilities are being designed and fabricated to meet the applicable Federal regulations, which include rigorous testing requirements. Section 2.1.2.1.1 of the EIS summarized the process by which waste packages would be loaded and sealed. All unloading of waste from transportation casks and loading and sealing of waste packages would be performed remotely in a manner similar to the way casks and canisters are loaded today for transportation and storage. DOE has extensive experience in designing, fabricating, testing, and implementing use of nuclear components. Over the past 30 years, there have been more than 2,700 U.S. spent nuclear fuel shipments in transportation casks with no releases.

DOE acknowledges that it cannot build a waste package that can be guaranteed to provide perfect containment forever. The EIS provides DOE's best estimate of the impacts that could occur when the containment system inevitably degrades. The Environmental Protection Agency, in promulgating the Yucca Mountain environmental protection standards (40 CFR Part 197), also recognized that with the current state of technology, it is impossible to provide a reasonable expectation that there will be "zero" releases over 10,000 years or for a longer period. Therefore, the Environmental Protection Agency has established standards that would protect human health and safety. These standards do not require complete isolation of the wastes over the compliance period (that is, 10,000 years) or the period of geologic stability (taken to be 1 million years). The goal of a performance assessment for Yucca Mountain supporting the site recommendation decision and later licensing (if the site was recommended) is to evaluate whether the repository is likely to meet these standards. The goal of this EIS is to project possible impacts using similar modeling technology. Chapter 5 of the EIS presents the results of these efforts, which show that releases under the Proposed Action would not exceed environmental protection standards (40 CFR Part 197) within 10,000 years of repository closure.

The design of the waste package, including its construction materials, has evolved from that used for the Viability Assessment reference design to the flexible design. While both use a two-layer waste package, the flexible design places the corrosion-resistant material on the outside rather than the inside the package to provide long-term protection to the more corrosion-susceptible structural material. The current waste package design includes a thick and very corrosion-resistant nickel-based alloy (Alloy-22) as the outer barrier, over a thick stainless-steel inner liner. Data on the corrosion performance of the waste package materials (including the internal structure) have been collected from DOE tests and from research literature. Testing would continue during waste emplacement and preclosure to collect long-term data under conditions prototypical of those expected at Yucca Mountain. The data generated would continue to be used by the scientists and engineers to determine the long-term performance of the materials as a part of the determination of total system performance in compliance with regulatory standards.

DOE based the development of models that predict the performance of corrosion-resistant, nickel-based Alloy-22 in the repository on data from research literature and testing. The Department performs long-term tests under expected repository conditions (months to years), and short-term tests (days to weeks) under expected repository conditions and conditions much more aggressive than those expected in the repository environment to provide confidence in the long-term performance of the materials. The American Society for Testing and Materials codified this approach (DIRS 105725-ASTM 1998). Analyses of the tests use a suite of tools, including standard microstructural evaluation and atomic force microscopy, which permits the examination of surface films in such great detail that DOE can evaluate even very slow degradation rates. DOE intends to continue to test samples of Alloy-22 (and other alloys that would be exposed in the repository) in the laboratory for decades to confirm the results collected to date. In addition, DOE would explore analogs of Alloy-22 to provide confidence in its performance.

DOE based the materials selection on the input of recognized subject-matter experts and laboratory tests, and from material performance observed in full-size industry applications. The corrosion tests involve Alloy-22 and other candidate waste package materials subjected to environments that are at least as aggressive as any expected inside Yucca Mountain. DOE would continue these tests during waste emplacement operations to confirm the expected waste package performance.

If the Secretary recommended the site to the President and the site was approved for further development, DOE would initiate testing as part of the performance confirmation program, elements of which would address the engineered barrier system. The purpose of this program would be to evaluate the adequacy of the information used to demonstrate compliance with performance objectives. The performance confirmation program, which would continue through closure of the repository (possibly more than 300 years after the end of waste emplacement), would monitor conditions at the waste packages in emplacement drifts and other systems important to performance, thereby reducing uncertainties.

7.1 (831)
Comment - EIS000160 / 0002
The Department is clear that the Yucca Mountain site cannot be depended upon to contain the waste. But rather than abandon the site, it is set out to design the undesignable: a container that can guarantee it will isolate the waste for as long as it remains hazardous. It is impossible for the Department -- regardless of what new technology or alloy may be invented -- to certify that an engineered container will hold up over the hundreds of thousands of years necessary to protect the environment and the public from releases from the site.

If we now accept that we must rely upon engineered barriers to contain the waste, then this program needs to be scrapped and redesigned from the bottom up. Yucca Mountain could not be said to have any distinct geologic advantage over any other site. There is a real possibility that no proposed geologic site in the United States would be able to meet the fundamental requirements for waste containment.

Response
DOE acknowledges that it cannot build a containment system that can be guaranteed to provide perfect containment forever. The EIS provides DOE's best estimate of the impacts that would occur when the containment system inevitably degrades. DOE does confirm in the EIS that the Proposed Action would be likely to result in release of radioactive contamination to the environment beginning as early as a few thousand years after repository closure. However, the EIS also shows that these releases under the Proposed Action would be far below environmental protection standards (40 CFR Part 197) within the 10,000-year compliance period for the repository, standards specifically enacted to ensure the safety of future generations.

The current approach by DOE is consistent with the NWPA, which recognizes the use of engineered features especially for defense-in-depth as noted in the following words from the Act:

“Such criteria shall provide for the use of a system of multiple barriers in the design of the repository…” [42 U.S.C. 10141(b)(1)(B)].

In addition, environmental standards recently issued by the Environmental Protection Agency for Yucca Mountain (40 CFR Part 197) as well as those issued by the Nuclear Regulatory Commission (10 CFR Part 63), require that DOE provide a reasonable expectation that the system (natural plus engineered barriers) would meet the performance objectives for the period after permanent closure. The analysis in the EIS suggests that these standards can be met by the total repository system (see Section 5.4.2).

To reduce the uncertainty inherent in long-term predictions of complex engineered and natural systems and improve the confidence in the system’s ability to ensure safety at Yucca Mountain, DOE made physical changes to the engineered system (for example, more robust and corrosion-resistant waste packages). The improved design and modeling approaches represented by the flexible design in the Final EIS show peak doses that would be much smaller than the values published in the Draft EIS at the most populous locations (see Section 5.4.2).

However, not all of this reduction is due to improved engineered systems. A substantial reduction would be due to more realistic models that better account for factors in the natural system. Part of the compliance strategy is a defense-in-depth approach under which various components of the engineered and natural system would supply independent attenuation of dose impacts.

7.1 (1220)
Comment - EIS000296 / 0006
We’re very concerned about some of the technical reviews that have taken place in the last couple of years about the Department of Energy’s work on containers. Alloy C-22, for example, under certain conditions, can be not passive and so can actually have penetration and a loss of integrity in only a few tens of years. So relying on containers is just not going to be workable, and pretending that there is a solution to the waste management problem is a grave danger because there are real problems to high-level nuclear waste. And pretending that there’s a solution just creates the incentive on the part of industry to extend their life, like Duke at Oconee 1, 2 and 3, and as nuclear utilities across the country are going to the NRC [Nuclear Regulatory Commission] to do right now. So pretending that you’ve got a solution causes a much bigger problem.

Response
DOE recognizes that any man-made material will fail under very adverse conditions given enough time. However, the potential for such adverse conditions to exist at Yucca Mountain is extremely low. Based on technical data to date, DOE is confident that the Alloy-22 of the outer waste package would be stable for extremely long periods. To further increase confidence in the long-term performance of Alloy-22, DOE is performing very-long-term testing under actual conditions and somewhat adverse conditions. In addition, DOE would examine waste packages remotely for several decades prior to closure of the repository for performance confirmation.

7.1 (2647)
Comment - EIS000409 / 0005
Plans for the Canisters: Is there any metal or metallic compound that can withstand temperatures of 300° - 360°C? The Nelson limits were created by observation of catastrophic failure whenever metallurgy was not appropriate to contain a variety of elements under harsh conditions. At the NRC [Nuclear Regulatory Commission] & DOE meetings 1 out of 100 canisters would blow. Is this the reason for the 12 mile buffer zone in the EIS?

MC I (my bugs) will enjoy eating the canisters (as proved by the tests performed by Livermore Labs at YM [Yucca Mountain] and the bugs will add even more poison into the water in the leaky mountain. Liability for on site accidents is also unknown.

Response
The EIS analyses did not reveal any instances where waste package temperatures would exceed 300ºC (570ºF). Such temperatures would only be possible from an igneous intrusion, which is an exceedingly unlikely disruptive

event. Maximum waste package temperatures would be less than 300ºC at all times. Both stainless steel and Alloy-22, the principal waste package materials evaluated for the flexible design in the Final EIS, are routinely subjected to higher temperatures in industrial applications. DOE is performing tests to examine the properties of Alloy-22 at elevated temperatures over extended periods.

The Nelson limits (Nelson curve) mentioned by the commenter is mainly applicable to embrittlement of carbon steels exposed to high (for example, greater than 100 pounds per square inch) partial pressures of hydrogen gas at high temperature [300º to 360ºC (570º to 680ºF)]. However, these limits do not apply to the waste packages because very little hydrogen gas is present and, for the updated flexible design, carbon steel is no longer used as one of the barriers. DOE has investigated hydrogen embrittlement for the waste packages and determined it not to be an important failure mechanism.

DOE disagrees with the assertion that the waste packages would rupture due to temperature induced internal pressures. Pressures of sufficient level to cause package rupture could only occur with temperatures far higher than those expected in the repository.

With regard to the 20-kilometer (12-mile) buffer zone [revised to 18 kilometers (11 miles) for the Final EIS based on recently finalized 40 CFR Part 197 regulations], for purposes of analysis, the extent of a land withdrawal area is important to understanding the impacts of the Proposed Action. For example, the magnitude of impacts to a member of the public from an accident at an operating repository would be determined in part by the proximity of the land withdrawal area to the repository operations areas. However, the withdrawal area is only in effect while there is active institutional control. For the Final EIS, the approximately 18-kilometer location prescribed by the regulators (40 CFR 197.21) for calculating potential doses to the reasonably maximally exposed individual was not based on the proposed land withdrawal boundary. This receptor location was based on the likely future location of a small community of persons and farms, given the physical setting of the potentially affected area, and the depth to water in that setting.

DOE acknowledges that certain microbes can survive on metallic surfaces under the right conditions (based on tests conducted at Lawrence Livermore National Laboratory on microbiologically influenced corrosion (DIRS 110016-Horn et al. 1998). However, the microbes do not eat the metal. The microbes may secrete substances that can alter the corrosion environment on the waste package. Studies of corrosion of the titanium drip shields indicate that the effect of microbial growth on the corrosion potential is not significant and the initiation of crevice corrosion under biological films formed on titanium has never been observed. Therefore, the drip shield material would not be affected by microbially influenced corrosion. Studies indicate that the Alloy-22 can be subject to this effect if the humidity exceeds 90 percent and sufficient nutrients exist. In the analysis used for the Final EIS, microbially influenced corrosion of Alloy-22 is represented by a corrosion enhancement factor represented in the probabilistic sampling of the analysis of long-term performance by a uniform distribution between 1.0 and 2.0.

7.1 (3482)
Comment - EIS001185 / 0001
What is the construction of the containers that will contain the nuclear waste? Will the waste be encased in an inert material such as glass? What assurance do we have for our children and grandchildren that there will be no leakage before the material is inactive? Are the final burial containers the same as those used for transport?

Response
As described in the Supplement to the Draft EIS (issued for public review in May 2001) and the Final EIS, the waste package would be a cylindrical container with a thick outer wall of high-nickel alloy (Alloy-22) and a thick inner wall of stainless steel. DOE selected the high-nickel material for corrosion resistance and the stainless steel, which is also corrosion resistant, for structural strength. The engineered barrier system, which would include the waste package as a key element, would preclude releases that represented a risk to populations for 10,000 years after repository closure.

The waste packages that DOE would place in the repository would be very different from the shipping casks used to transport the waste to the repository. The shipping casks would be large containers designed for transport by railcars or trucks. The shipping cask would be designed to protect people from exposure to radiation and to contain the waste in the event of a severe transportation accident. The Nuclear Regulatory Commission would license the container designs for waste transport, but not for disposal in the repository.

Sections 5.2.2 and I.2.4 of the Final EIS contain more information on the design and expected lifetime of the waste package.

7.1 (4872)
Comment - EIS000337 / 0010
Pg. 2-57: The three bullets indicate that DOE will continue to study design improvements. Why can't these studies be used in the No-Action Alternative and thus improve the storage life at the various sites?

Response
The Nuclear Regulatory Commission, the Electric Power Research Institute, and DOE are currently sponsoring a program to examine fuel that has been in dry storage for 15 years. These studies might result in improved designs for onsite storage facilities. However, under the NWPA, DOE is responsible for determining the suitability of the Yucca Mountain site for a geologic repository. The determination of site suitability will be based on the expected long-term performance of the natural and engineered barriers. The engineered barriers include the waste package. It is prudent, therefore, that DOE continue to investigate improvements to the design of the waste package that could further reduce the eventual release of radioactive materials from the repository.

Future improvements in dry storage technology could reduce the environmental consequences of the No-Action Alternative. However, DOE has no control over the storage of commercial spent nuclear fuel at utility sites. Therefore, it would not be justified for DOE to take credit in the EIS for reductions in the projected environmental consequences of the No-Action Alternative from unspecified, future dry storage technology.

7.1 (5368)
Comment - EIS001887 / 0085
Page 2-32; Section 2.1.2.2.2 - Waste Package Design

The current design of the waste package has the two layers flipped. The Alloy-22 is now on the outside of the canister with the carbon steel on the inside.

Response
The current waste package design utilizes a thick outer barrier of a corrosion-resistant nickel-based alloy over a thick inner structural liner of stainless steel. This is a change from the early design in the Draft EIS. This newer design has expected superior corrosion performance, so that the Draft EIS results are conservative in regard to waste package lifetime. The Final EIS includes the current waste package design.

7.1 (5369)
Comment - EIS001887 / 0086
Page 2-32, Section 2.1.2.2.2 - Waste Package Design

Issues of criticality are addressed by stating that neutron absorbers (if needed) would be placed within the waste package so that no criticality could take place "even if the package somehow became full of water." There is no discussion of the resultant possible steam explosion that could occur if water made contact with the waste form. A steam explosion could be almost as bad as a criticality incident. Any kind of explosion inside an emplacement drift could be detrimental to the entire repository block.

Response
The potential for a steam explosion, or any other kind of explosion, inside a waste package or within an emplacement drift is not credible. Rapid expansion of water to create a "steam explosion" would require an appreciable amount of water being dumped on the waste form while temperatures are well in excess of 100°C (212°F). As discussed in Section I.4.3.3 of the Draft EIS, penetration of the outer barrier of the waste package would not be expected before 800 years. Penetration of the inner barrier would only be expected in a very small fraction of the emplaced waste packages within 10,000 years. Such failures would be the earliest opportunities for water to contact the waste form. By this time, waste temperatures would be well below 100°C. For the flexible

design evaluated in the Final EIS, package failures would be expected to occur later than with the Draft EIS design because of improved waste package design and the addition of titanium drip shields.

7.1 (5370)
Comment - EIS001887 / 0087
Page 2-34; Figure 2-21 - Conceptual design of waste package in emplacement drift.

The current conceptual design of the emplacement drift does not include a concrete liner. The current conceptual design of the emplacement drifts should be described in Section 2.1.2.2.3, Waste Package Emplacement Operations.

Response
DOE believes that ongoing site characterization and design-related evaluations would demonstrate a continued improvement in repository performance and a reduction in associated uncertainties. However, DOE also recognizes that since publication of the Draft EIS, certain key aspects of the design (for example, waste package design and use of drip shields) have changed in ways that are important to repository performance and reduction in uncertainties. For this reason, DOE published the May 2001 Supplement to the Draft EIS, which focuses on the most recent base design, including various thermal management strategies. DOE believes that the level of information provided for each element (for example, waste handling facilities, heat management scenarios, and transportation alternatives and scenarios) of the Proposed Action is sufficient to provide a meaningful assessment of environmental impacts for review by the public and the decisionmakers, and thus the timing of the EIS is appropriate.

7.1 (6422)
Comment - EIS001632 / 0010
Page 2-32: The second paragraph contains a general description of the waste package used for the performance assessment. The description of the waste package must be updated in the Final EIS.

Response
As described in the Supplement to the Draft EIS and incorporated into the Final EIS, the waste package has been redesigned to include a thick outer shell of a corrosion-resistant high-nickel alloy (Alloy-22) and a thick inner shell of stainless steel for strength. This newer design would resist corrosion far better than the design described in the Draft EIS, and would improve the predicted performance of the repository and reduced uncertainties associated with that performance. Section 2.1.2.2.4 of the EIS describes the waste package design.

7.1 (6481)
Comment - EIS001774 / 0003
There is not a shred of evidence to support that thermally hot, highly radioactive fuel rods will stay intact at any site. We're supposed to comment on non-existent and untested technology at an inappropriate site. According to DOE document DE-AC04-84A-25747, "These wastes have a potential for causing great harm." They are thermally hot, 250,000 BTUs per hour and highly radioactive. A ruptured cask either in transport or in the dump itself would be a major environmental disaster that could contaminate a large area. The recent small disaster in Japan would be nothing compared to a breach of containment.

Response
The waste that DOE would place in the repository would be mainly commercial spent nuclear fuel and DOE high-level radioactive waste. The spent nuclear fuel would be clad in an alloy of zirconium containing small alloying additions. It would be very resistant to corrosion, and the chemical industry has used it for more than 50 years to contain very aggressive chemical solutions. The cladding has operated at high temperatures and pressures in commercial nuclear reactors for as long as 3 years before removal and storage at the reactor site. Only a very small fraction of this cladding, less than 1 percent, has failed in service, and failure rates have decreased with improvements in fuel-rod design. Through modeling, DOE evaluated the degradation of this cladding in the repository and found that it would remain intact for thousands of years.

As described in the Supplement to the Draft EIS and the Final EIS, the waste package has been redesigned to include a thick outer shell of a corrosion-resistant high-nickel alloy (Alloy-22) and a thick inner shell of stainless steel for strength. DOE has evaluated the waste package design for resistance to chemical and mechanical degradation and evidence suggests that waste packages would survive intact for tens of thousands of years. DOE's confidence in the corrosion resistance of Alloy-22 is bolstered by years of industry experience, input from independent experts, ongoing lab tests that would continue well into the repository operations period, and a fabrication program that is examining the impact of fabrication and welding on material performance.

DOE recognizes that accidents could occur during the transportation of spent nuclear fuel and high-level radioactive waste. For this reason, the EIS evaluates risks and impacts to the public from accident scenarios that are highly unlikely but that would have severe consequences (called maximum reasonably foreseeable accident scenarios). For the maximum reasonably foreseeable accident scenarios, the analysis selected the accident scenario from the 32 possible combinations of weather conditions, population zones, and transportation mode that would have a likelihood greater than 1 in 10 million per year and would have the greatest consequences. Table 6-12 lists the impacts from such an accident.

In a similar manner, DOE has evaluated potential impacts from accidents that could occur at the repository that could result in a cask rupture. The results of these accident scenarios are presented in Section 4.1.8 of the EIS.

7.1 (6576)
Comment - EIS000817 / 0001
The history of dry cask storage of the VSC-24 cask, which was a complete fiasco, is a foretelling of the future of cask behavior at Yucca Mountain.

Response
Waste would be emplaced in waste packages, not casks. The materials used to construct the waste packages would be thoroughly tested throughout the decades-long period prior to closure of the repository. The waste packages themselves would be subject to thorough nondestructive testing. In addition, prototype waste packages would be tested to confirm that they would withstand design-basis accidents.

7.1 (7049)
Comment - EIS001337 / 0011
Lincoln County and the City of Caliente encouraged DOE to consider alternatives for accomplishing the waste emplacement phase of the repository within the DEIS. The County and City noted that perhaps most important would be the evaluation of various candidate materials from which waste packages might be fabricated. Options suggested by the County and City which DOE might consider include those characterized as corrosion resistant, corrosion allowance, and moderately corrosion resistant. Each option was noted as performing differently under alternative thermal and geochemical environments. The County and City recommended that each alternative considered in the DEIS be characterized by varying contributions to risk management, cost and uncertainty. The County and City recommended that a similar evaluation be included for alternative materials for fabrication of waste package baskets. The DEIS does consider alternative design concepts and design features intended to limit release and transport of radionuclides. The DEIS does not provide an assessment of the relative contributions to risk management, cost and uncertainty associated with each alternative considered. The information in the DEIS is therefor of limited value for decision-support.

Response
As encouraged by Lincoln County and the City of Caliente, DOE has considered, and continues to consider, enhanced or improved methods of implementing waste emplacement, including waste package materials and repository design.

As a result of the evaluations in the *Viability Assessment of a Repository at Yucca Mountain* (DIRS 101779-DOE 1998) and concerns such as those of the Total System Performance Assessment Review Panel, DOE modified the waste package design and added a drip shield over the waste packages. The waste package would have Alloy-22 as the outside layer with stainless steel on the inside. The titanium drip shield would add further defense-in-depth to the design.

DOE based the waste package corrosion model in the Final EIS on the corrosion experiments on Alloy-22 at Lawrence Livermore National Laboratory. Those experiments showed that Alloy-22 is very corrosion-resistant and, even accounting for uncertainty, would be unlikely to fail for many thousands of years.

Because of these evolving design changes, DOE issued a Supplement to the Draft EIS in May 2001. The information in the Supplement, which DOE has incorporated to the Final EIS, describes the potential impacts associated with the design modifications. In the case of the Alloy-22 package material, DOE considered its thermal, mechanical, and chemical performance (corrosivity), ease of fabrication, costs, and compatibility with other materials.

7.1 (7376)
Comment - EIS001614 / 0002
I would like to comment on why I believe Yucca Mountain will fail to isolate waste. DOE's own data shows that Yucca Mountain site will fail to contain nuclear waste. Radioactive gases will be released and radioactive waste will be washed into the groundwater a short time after the first containers fail.

Containers do fail. About 70 dry storage casks are in use at reactors. There is already one juvenile failure, a cask with a faulty weld in less than 20 years. Repository casks will be made of different material, but the manufacturing will be subject to the same problems. There will be more than 10,000 repository casks, and so likely hundreds of early cask failures.

Response
DOE acknowledges that it cannot build a containment system that can provide perfect containment forever. The EIS provides the Department's best estimate of the impacts that could occur when the containment system inevitably degraded. The EIS confirms that the Proposed Action would be likely to result in release of radioactive contamination to the environment after repository closure. However, the EIS shows that these releases under the Proposed Action would not exceed environmental protection standards (40 CFR Part 197) within 10,000 years of repository closure, standards specifically enacted to ensure the safety of future generations.

In addition to the 10,000-year compliance period, DOE has evaluated potential impacts for the period of geologic stability at the repository (that is, 1 million years). This evaluation was performed in accordance with 40 CFR Part 197 to gain insight into the long-term performance of the repository and thus provide information for the decisionmakers in making both design and licensing decisions. These results show a mean peak dose rate that is much lower that background levels (see Chapter 5 of the EIS for details).

The Yucca Mountain Repository, as described in the Supplement to the Draft EIS, would include a robust engineered barrier system designed specifically to work with the favorable natural barrier system at Yucca Mountain. The waste package would not be the only engineered barrier. The engineered barrier system design has evolved since the publication of the Draft EIS and will continue to evolve. The current design includes a more robust and corrosion-resistant waste package and a titanium drip shield above each waste package for defense-in-depth against corrosion. In addition, the structural steel material used for ground support in the drifts and the titanium drip shields would protect the waste packages against rockfalls.

DOE understands the concern about the use of dry storage casks. However, the Department would not use such casks for disposal in the repository. The problem cited in the comment has been widely documented in Nuclear Regulatory Commission bulletins, inspection reports, letters, and other public documents; it was attributed in large part to the failure of the licensee to implement the required quality-assurance and quality-control standards. However, no measurable consequences have resulted from weld defects, and this type of storage cask is still safely in use.

The longevity of the waste package is a principal factor in the EIS safety case. The evaluation of alternative waste package designs presents a sound technical basis for likely projected lifetimes beyond 10,000 years for the reference dual-shell design under a range of thermal, geochemical, hydrological, and radiological conditions. This container would consist of an inner shell of stainless steel and a thick, corrosion-resistant outer shell of a high-nickel alloy (Alloy-22). The updated analysis in the Final EIS projects the possibility of between zero and five packages failing due to manufacturing defects.

7.1 (7576)
Comment - EIS001912 / 0069
Almost 95 percent of waste containment is now being attributed to the waste package. DOE must include a discussion of information about waste packaging materials, which supports a level of performance capable of meeting the regulatory standard.

Response
The engineered barrier system, of which the waste package is a key part, would prevent the annual dose to an average individual living 18 kilometers (11 miles) from the repository from exceeding 15 millirem total effective dose from all pathways and all radionuclides in the first 10,000 years after closure, as prescribed in 40 CFR Part 197. As described in the Supplement to the Draft EIS and in the Final EIS, the long-term performance calculations were based on a waste package with a thick outer wall of high-nickel alloy (Alloy-22), which is highly corrosion-resistant, and a thick inner layer of stainless steel, which is also corrosion-resistant, and which would provide structural strength. This design includes a support structure for the waste package of Alloy-22 and a drip shield of titanium.

7.1 (7611)
Comment - EIS002027 / 0002
When it's stored will the containers open or crack because the molecules are expanding?

Response
DOE anticipates that most of the waste packages would not open or crack for any reason for at least 10,000 years. The materials used to fabricate the waste packages would be stable alloys. The fabrication welds in the waste packages would be annealed and thoroughly inspected to prevent the initiation of any type of failure as a result of fabrication defects. Increases in internal pressure due to high temperatures would not be sufficient to cause a waste package to rupture. In addition, DOE would monitor the waste packages for as long as practicable up to the time of permanent closure to verify performance.

7.1 (7927)
Comment - EIS000817 / 0040
And the sodium and aluminum salts in HLW need close evaluation as to [their] eventual interaction with cask materials (as things break down in a repository).

Response
Corrosion of the waste packages in the repository, given enough time, is inevitable. Before the start of site characterization, there was a general belief that thin-walled stainless-steel waste packages would be sufficient. The evolving design of the repository, as described in the Supplement to the Draft EIS and the Final EIS, now includes a more robust waste package and titanium drip shields to delay by more than 10,000 years the release of radionuclides from the repository.

DOE's understanding of corrosion is based on research literature and long- and short-term testing of the waste packages. These tests are conducted under conditions that are expected in the repository, as well as very aggressive conditions. The American Society for Testing and Materials codified this approach in *Standard Practice for Prediction of the Long-Term Behavior of Materials, Including Waste Forms, Used in Engineered Barrier Systems (EBS) for Geological Disposal of High-Level Radioactive Waste* (DIRS 105725-ASTM 1998). The tests use standard microstructural evaluation and atomic-force microscopy to examine surface films in such detail that DOE can evaluate extremely slow rates of degradation. DOE would continue to test samples of Alloy-22 (the waste package material) and other materials for many decades to confirm the results that have been collected to date.

7.1 (7931)
Comment - EIS002005 / 0001
My class is studying on the nuclear waste and I was just wondering what it's like down there.

Where does the waste go every month? Do you burn everything that's trash and what time do you leave from the nuclear waste?

Response
At present there is no radioactive waste disposal taking place at Yucca Mountain. This EIS evaluates potential impacts for the proposed repository if the site is approved. DOE scientists at Yucca Mountain are studying the inside of the mountain via an 8.9-kilometer (5.5-mile) long tunnel bored through the rock into the mountain. Inside the tunnel, it is mostly dry and fairly warm throughout the year.

Spent nuclear fuel and high-level radioactive waste cannot be treated by burning, and DOE has no plans to burn any types of waste at the proposed repository. If the site was approved, the waste transported there would be emplaced in the mountain. DOE plans to dispose of low-level waste from repository operations at a low-level waste disposal facility at the Nevada Test Site.

7.1 (8000)
Comment - EIS000817 / 0055
You talk about neutron absorbers. You don't know how long they will maintain their integrity. That is a big question here. It is not time tested for dry cask storage yet.

Response
The most important function of the neutron absorber would be to absorb neutrons and reduce the potential for criticality. The absorber material is typically an additive material (for example, stainless steel alloyed with a boron compound). The carrier material with the added neutron absorber would be part of the internal structure in the waste package. Corrosion behavior would be important in keeping the absorber material in place and effective in controlling criticality long after emplacement. Therefore, DOE used chemical performance in a variety of environments as an important selection criterion. In addition, the Department used mechanical performance as an evaluation factor because the internal components must be able to sustain mechanical loads due to handling, emplacement and, if necessary, retrieval. The analysis considered compatibility with other materials because the neutron absorber components must not degrade the waste form. These components provide an important path for conducting heat from the fuel to the waste package layers, so the analysis considered thermal performance. The material of choice for the neutron absorber is Neutronit A978. DOE based this selection on the corrosion performance of this material in comparison to other candidate materials and available boron concentration (DIRS 138192-CRWMS M&O 2000). The composition of Neutronit is similar to that of American Society for Testing and Materials standard Type 316, but with 1.6 percent boron. Based on the selection process used and the performance of similar material, there is no reason to expect untimely failure of the neutron absorbers.

7.1 (8004)
Comment - EIS000817 / 0059
So many unexpected problems have developed already. Nobody expected coating reactions or that they would have to UT [ultrasonically test] the seal welds. There are too many unknowns in dry cask storage to already think of disposal casks that will really work as planned. All you have is a "preliminary conceptual" design. I read the full transcript of the Nuclear Waste Technical Review Board meeting on this cask design and if shrink fitting is still an option, I think it's a mistake. Not enough experience with this.

Response
DOE understands the commenter's concern about the use of dry storage casks. However, DOE would not use such casks for disposal in the repository. As described in the Supplement to the Draft EIS (released for public review in May 2001) and in the Final EIS, the design of the repository now includes a more robust waste package and titanium drip shields. This design would delay by more than 10,000 years the release of radionuclides from the repository.

The unexpected problems mentioned by the commenter presumably refer to use of the Ventilated Storage Cask, Model 24 (VSC-24) storage system. These problems are widely documented in bulletins of the Nuclear Regulatory Commission, inspection reports, letters, and other public documents. The VSC-24 storage system uses a mostly carbon-steel fuel basket (internals and shell) with anti-corrosion coatings. The majority of the spent-fuel storage technologies use stainless steel and no or limited amounts of anti-corrosion coatings. Many of the problems of the VSC-24 system resulted from a failure of the licensee to adequately implement the required quality-assurance and quality control programs. Several problems were associated with the anti-corrosion coatings and hydrogen-induced weld cracking. The weld defects were detected using the inspection and testing procedures approved by the Nuclear Regulatory Commission that are intended for this process and resulted in no release of radioactive material. The

Nuclear Regulatory Commission used its regulatory authority to formally address each of these problems, including halting the use of this particular system until the issues were addressed and resolutions implemented. Resolutions included design and procedural changes and development of alternate inspection techniques.

The VSC-24 problems are important in that lessons have been learned that can be applied to existing and future storage-system technologies. However, the problems that occurred with one system do not support the claim that dry-storage-cask systems approved by the Nuclear Regulatory Commission would not work. DOE believes that dry storage and transportation technologies that have been approved by the Nuclear Regulatory Commission are sound and viable. In support of this view are the thousands of shipments of spent nuclear fuel that have been transported safely over the past several decades.

7.1 (8029)
<u>Comment</u> - EIS000817 / 0073
Fuel rods in dry storage are likely to be environmentally secure for long periods -- you state this as if you have some evidence -- what, I'd like to know? The "generic" (so-called -- but each one gets so many changes, it ends up "site-specific" anyway) casks NRC [Nuclear Regulatory Commission] is certifying are new designs -- never built or tested in full scale -- with real fuel over time -- never unloaded. You have no real evidence from fuel stored in any of these cask designs to prove this "likelihood" you refer to. I'd like to see each cask design unloaded after 5, 10, 15 years and an inspection of assemblies inside and full evaluation of impacts of unloading on the cladding and pellets. All your computer analysis will not tell us the real thing any more than all the computer analysis for the VSC-24 [Ventilated Storage Cask, Model 24] told us that a coating would cause a hydrogen explosion. If nobody enters the right data, nobody knows about uncertainties, right? There are too many uncertainties. Test the real thing. Unload casks. This has to be done. I've been requesting it for years and years.

<u>Response</u>
Both Canada and Germany have evaluated spent nuclear fuel in dry storage. The United States has not performed any analysis until recently on the behavior of spent nuclear fuel in long-term dry storage. As part of a cooperative program among DOE, the Nuclear Regulatory Commission, and the Electric Power Research Institute, spent nuclear fuel in dry storage is now being examined. Recently, a dry storage cask that has been located on a concrete pad at the Idaho National Environmental and Engineering Laboratory for more than 13 years was opened and the 17 assemblies of Surry fuel have been examined remotely using a video camera. No changes were observed. One assembly was chosen, and selected rods were removed for further nondestructive and destructive analysis. The nondestructive analysis is in progress.

The temperature of the spent nuclear fuel in the repository, and the rate of its degradation, would decrease over time. Thus, there is little benefit to evaluate the condition of spent nuclear fuel rods or assemblies after about 10 years of disposal. However, testing samples of spent nuclear fuel would continue in order to confirm predictions of alteration and release mechanisms.

7.1 (8032)
<u>Comment</u> - EIS000817 / 0076
You say here that most utilities and DOE have not constructed ISFSIs [independent spent fuel storage installations] -- right! Dry cask storage is in its infancy, yet your whole plan is based on it working as predicted. Why is your EIS based on horizontal modules rather than vertical? Horizontal, such as Nuhoms, have to rest on a pedestal. Is that the best way? Why? Is a stainless steel outer shell the best (better than carbon steel)? -- I would think it is. But why have you chosen this cask design above others certified by now? Where is your comparison of descriptions of all casks on the market? Are these casks really safe in an airplane crash as you insinuate? With a fuel fire from the plane?

<u>Response</u>
About one-third of the commercial utility sites have constructed, or are planning to construct, independent installations to store spent nuclear fuel. The function and design of these installations are substantially different than the function and design of the waste packages that DOE would place in a repository at Yucca Mountain. Independent spent fuel storage installations are for above-ground interim storage of spent nuclear fuel that DOE would ultimately ship to the repository. Most of the five DOE sites evaluated in the EIS have some dry-fuel-storage capability.

Chapter 7 of the EIS evaluates the likelihood and effects of an airplane crash into dry-vault storage facilities at reactor sites. The consequences of such an accident would not pose undue risks to the health and safety of the public. Airplane crashes into emplacement areas at the repository for waste packages that have been emplaced are not an issue because the waste packages would be far underground. Aside from activities in the Waste Handling Building, spent nuclear fuel would be at the surface only if postemplacement retrieval was required or if DOE implemented surface aging prior to emplacement in support of lower-temperature operating mode thermal management objectives (see Section 2.1.2.1.1.2 of the EIS).

Any design concepts for such a surface aging facility are preliminary, but it would be licensed in compliance with Nuclear Regulatory Commission requirements (10 CFR Part 72). These requirements specify that storage modules must be able to withstand credible accidents. If the repository was approved for development and if a lower-temperature operating mode was selected that required surface aging, DOE would incorporate the latest dry storage technologies into the design, including lessons learned from independent spent fuel storage installations.

DOE evaluated the consequences of an aircraft (both military and large commercial jet) crash into surface facilities at the proposed repository, including into a potential surface aging facility. It was determined that a large commercial jet aircraft would not penetrate the surface aging storage modules.

7.1 (8056)
Comment - EIS002026 / 0002
I think the tests on the containment casks are a waste of time. They're minimal at the best.

Response
The Yucca Mountain repository design includes a robust engineered barrier system and takes advantage of the natural barrier system (dry environment and geologic features). The waste package would not be the sole engineered barrier. The engineered barrier system design has evolved since the publication of the Draft EIS and will continue to evolve. The current design includes a more robust and corrosion-resistant waste package, in addition to a titanium drip shield above each waste package for defense-in-depth against waste package corrosion. Structural steel material used for ground support in the drifts and the titanium drip shields would provide protection to the waste package against rockfall.

DOE has completed extensive evaluations of the best materials for the containment function of the waste package. The Department performed material analysis by selecting weighting criteria and establishing grading scales. Weighting criteria included mechanical performance, chemical performance (corrosion), predictability of performance, compatibility with other materials, ease of fabrication, cost, previous experience, thermal performance, and neutronic performance. Data on the performance of the materials of the engineered barrier have been collected from tests conducted by DOE and from literature based on extensive industry experience in fabrication and use of these materials. Testing would continue during waste emplacement and preclosure to collect long-term data under conditions prototypical of those expected at Yucca Mountain. The data generated would continue to go to analysts who would determine the long-term performance of the materials as a part of the determination of total system performance in compliance with regulatory standards. In addition, DOE will implement fabrication testing of full-diameter waste package mockups.

DOE would design and build waste packages to meet applicable Federal regulations, which include rigorous testing requirements. The Department has extensive experience in designing, fabricating, testing, and implementing nuclear components. Over the past 30 years, there have been more than 2,700 U.S. spent nuclear fuel shipments in transportation casks with no releases.

7.1 (8283)
Comment - EIS001615 / 0001
I would like to ask a question of the materials engineers concerning their design of the final encasement of the products.

They're encasing these centered fuel elements in a multi -- an engineered multilevel metal container, and they have already said that they are producing radioactive gases inside this system that is leakproof. It will also produce helium gas as part of the radioactive decay processes.

I anticipate that there will be a significant increase in the pressure inside these vessels and the radiation that is produced from the decay of these products, both beta decay and alpha decay, will cause embrittlement internally. And because they are alpha emitters, the material will undergo alpha creep through the fractures and the gas will enhance the fracturing process over several years.

My question to the DOE is, what is the overpressuring that will develop inside these vessels, and with cooling, will that produce the possibility of the fracturing process? And since they are not vented, is there a possibility of helium gas causing the fissioning of the uranium and plutonium that are inside these fuel pellets?

Response
The radiolytic gases produced from decay of the waste would be a small fraction of the total pressure of the system. Also, this decay would not generate significant radiation damage to the waste packages. The integrated dose over tens of thousands of years would be less than the threshold for damage for the materials selected for the waste package. The helium generated would not cause fissioning of the nuclear material.

7.1 (8294)
Comment - EIS000817 / 0106
P. 4-88 Disposal Containers -- do not use carbon steel. Will you UT [ultrasonic test] the top welded closures? 16 different containers -- sounds like a real mess in figuring interactions when they all degrade!

Response
The waste package design analyzed in the Supplement to the Draft EIS (released for public review in May 2001) and in the Final EIS, includes a corrosion-resistant nickel-base alloy (Alloy-22) as the outer barrier material. The closure weld would be performed remotely. Inspection would include both visual and ultrasonic (test cut) methods. All of the waste packages would be made from the same materials (Alloy-22 on the outside; stainless steel on the inside) and take on the same basic shape. Thus, corrosion chemistries would be identical for all of the waste packages.

7.1 (8299)
Comment - EIS000817 / 0108
"Polypropylene sheath"? What is the fire hazard here?

Response
DOE would use the polypropylene sheath discussed in Section 4.1.15.3 of the EIS to provide neutron shielding for the transportation cask. The Department does not believe there would be an undue fire hazard. Polypropylene and related materials are in use today for neutron shielding for transportation casks and other container systems certified by the Nuclear Regulatory Commission.

7.1 (8569)
Comment - EIS000817 / 0177
P. 9-16. What do you mean, "waste package self shielding"? Like what?

Response
The concept of self-shielding for waste packages as presented on page 9-16 of the Draft EIS refers to an additional barrier around the waste package. This barrier would not necessarily provide additional corrosion resistance. This barrier would have to be sufficiently thick to reduce radiation levels to the point where limited human access in the emplacement drift would be possible provided air temperatures inside are low enough. The concept of self shielding is not currently under active consideration by DOE (see Section E.2.2.10 of the EIS).

7.1 (8577)
Comment - EIS000817 / 0183
P. E-20. Self shielding sounds like a good idea.

Response
The concept of waste package self-shielding referred to in Sections 9.2.10 and E.2.2.10 of the EIS is one of several design features that DOE examined to assess how the design could evolve in the future and how this evolution would relate to the assessment of environmental impacts.

The concept of self-shielding for waste packages refers to adding a shielding material around the waste package. This barrier would not necessarily provide additional corrosion resistance. This barrier would have to be sufficiently thick to reduce radiation levels to the point where limited human access in the emplacement drift would be possible, provided air temperatures inside were low enough.

Potential drawbacks to self-shielding could include increases in the size, weight, or quantity of waste packages and increased drift excavation, thus posing additional industrial safety risks. Shielded waste packages could also be more difficult to monitor since the barriers relied upon for protection against corrosion would not be visible. Shielded waste packages could also make it more difficult to maintain peak cladding temperatures below 350°C (660°F) to protect the integrity of the cladding.

7.1 (8658)
Comment - EIS000817 / 0198
Be very careful to evaluate the manufacturers' sheets on any neutron shield material. The RX277 in the shield lid of the VSC-24 [Ventilated Storage Cask, Model 24], for example, was supposed to be baked to 350° and then moisture was driven out -- and gases formed. The sheet, which I don't remember in detail, said something about how high the temperature should be allowed to go in casks and also that it could require moisture under situations. But the main thing about any enclosed poured material like this is that it has to be completely enclosed. This material, and material in the transfer cask wall, got wet at some locations when in the pool as all paths to the material were not welded shut. This could be a big concern in disposal casks as some materials actually attract moisture, and if trapped moisture is inside a cask to begin with, you have problems. Also Boral and Boral panels -- will it have continued efficiency? And is any type of poured neutron shield really safe? -- Uncontrolled voids can cause real problems. Also is helium in the cask dry? Really dry? Are weld areas preheated, and are welds done so that they are as strong as the parent metal? Are they UT [ultrasonically] tested? What is the basis for the critical flaw size acceptance? Are bolted casks better than welded ones? Is an inflatable annulus seal acceptable? Some neutron shield material is a plastic sort of stuff and flammable. What are the highest cladding temperatures for the cask design? How does it affect the Zircaloy? Watch for radiation streaming areas. (A lot of things to consider in dry casks.)

Well again I do think that materials interactions in cask materials and in all materials in the repository are your biggest unknown and your biggest problem.

Response
The current design of the waste package, as described in the Supplement to the Draft EIS, does not include any Boral as a neutron absorber. The neutron absorber material is typically in the form of an additive material (for example, stainless steel alloyed with a boron compound). The design of the waste package incorporates the neutron-absorber within the internal component structure in the waste package, when needed for criticality control. Corrosion behavior is important in keeping the neutron absorber material in place and effective in controlling criticality long after emplacement. Therefore, chemical performance in a variety of environments was used as an important selection criterion. Mechanical performance, compatibility with other materials, and thermal performance were also considered. The current design uses Neutronit A978.

This comment referred to the plastic sheath that is used as an outside cover for shipping casks to serve as a neutron shield (Section 4.1.15.3 of the EIS). The design of the transportation casks must include the capability to survive significant fire events. Moreover, Nuclear Regulatory Commission requirements for cask licensing do not permit the use of materials that would increase the risk of fire. The waste packages do not use plastic or any other flammable materials.

The current design of the disposal container (called a *waste package* upon emplacement) includes five welded closure lids. All of the welds in the disposal container would be subjected to thorough inspection. Welds are the choice for disposal container closure due to their ability to provide a long-term leak-resistant environment for the waste. A bolted/gasketed or inflatable seal closure is not included in the disposal container design because it cannot ensure adequate sealing capability in the long term without periodic replacement of deteriorated gasket or seal components. To the maximum extent practicable, disposal containers would be fabricated and inspected in accordance with the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (DIRS 141257-ASME 1995). The specified weld inspections and acceptance criteria (that is, flaw size) are based on the requirements of that Code for ensuring an adequate closure seal.

Radiation streaming, if any, will be considered in the design of the remote handling and emplacement systems. A shielded transporter and remote handling accomplish radiation protection during emplacement. Shielding analysis has been analyzed for streaming in the emplacement and handling equipment designs.

The interior of the disposal containers would be dry; they would be dried by pulling a very low vacuum and refilled with inert gas. The maximum cladding temperature permitted in the waste package would be 350ºC (660ºF). This temperature is based on test data that identified the maximum temperature at which cladding is not susceptible to creep rupture. Actual cladding temperatures probably would be much lower.

7.1 (8777)
Comment - EIS001907 / 0017
A Multi-purpose canister (MPC) seems to make the most sense---why move the assemblies around more than necessary, right? To date however, no MPC has undergone full-scale testing and under current NRC [Nuclear Regulatory Commission] regulations, none ever will. The DOE is relying on computer models, and scale testing (though the scale testing doesn't seem to be needed by law). There is a program going on at the test site right now, called Stockpile Stewardship and Management, which claims that computer models aren't enough to test the reliability of aging nuclear weapons in the stockpile, yet computer models are all we, the citizens have to protect us against nuclear waste moving on our roads and rails??

Response
DOE remains receptive to the idea of using multipurpose canisters to load spent nuclear fuel assemblies at utilities, transport them to Yucca Mountain, and emplace them in the repository. DOE agrees that multipurpose canisters can reduce the number of times fuel assemblies have to be handled. Any multipurpose canister to be used in transportation and emplacement would have to comply with the Nuclear Regulatory Commission regulations for transportation casks (10 CFR Part 71) and regulations governing disposal of high-level radioactive wastes in a repository at Yucca Mountain (10 CFR Part 63).

The Stockpile Stewardship and Management Program deals with the reliability of nuclear weapons. The assertion that computer models are not sufficient to characterize the condition of nuclear weapons as they age is based on the fact that minute changes in the isotopic composition and dimensions of the weapon can dramatically alter expected behavior. Confidence in computer models available to evaluate the mechanical stress, radiation shielding, and heat transfer behavior of multipurpose canisters is based on how well such models have predicted the behavior of similar containers and other objects in the past. While full scale testing of a multipurpose canister is not explicitly required by the Nuclear Regulatory Commission, there is no guarantee that the Nuclear Regulatory Commission would be willing to rely solely on scale testing and computer analysis of a multipurpose canister to demonstrate compliance.

7.1 (8935)
Comment - EIS001922 / 0007
The containment of radiation is based on integrity of the casks. When the DEIS estimates accident scenarios, it underestimates the risks posed by groundwater flowing directly from the site to the agricultural community in Amargosa Valley. It is impossible and fallacious to develop the assumption that the casks will not leak during transportation and emplacement when the casks have not been designed yet. We feel that, at the very least, the containers should be determined and subjected to full-scale testing. The DEIS should be revised to reflect new container information.

Response
This comment is correct that the various accident scenarios evaluated for the repository (see Chapter 4 of the EIS) and transportation (see Chapter 6) did not include an evaluation of possible groundwater impacts. This is because

even if these accidents occurred, the consequences would be mitigated to the extent necessary to preclude long-term impacts to groundwater.

DOE agrees that casks could develop leaks during transportation. For this reason, the Nuclear Regulatory Commission would require and DOE would implement a rigorous quality assurance program that would include testing and inspection of equipment and waste containers during every step of the transportation, handling, and emplacement activities. DOE believes that successful implementation of an effective quality assurance program would provide the ability to detect and repair damaged or leaking casks prior to emplacement in the repository.

Transportation casks licensed by the Nuclear Regulatory Commission (10 CFR Part 71) are very different from the waste disposal packages designed for the proposed repository. The Commission has certified a number of tests on casks. Required tests on the structural integrity of transportation casks require that they not release their contents after a drop of 9 meters (30 feet) onto an unyielding surface. Transportation casks have been safely used in more than 2,700 shipments of spent nuclear fuel in the United States. See Section M.4 of the EIS for additional information on cask safety and testing.

DOE is designing containers for the permanent disposal of spent nuclear fuel, which the EIS refers to as waste packages. Samples of candidate metals for waste packages are undergoing laboratory tests. Full-diameter, one-third-length mockups of different waste packages have been built to demonstrate techniques for welding lids to packages. Full-scale prototype testing of waste packages may also be necessary.

The Draft EIS evaluated the preliminary design concept described in the *Viability Assessment of a Repository at Yucca Mountain* (DIRS 101779-DOE 1998) for repository surface facilities, and disposal containers (waste packages). It also evaluated the plans for the construction, operation and monitoring, and closure of the repository. DOE recognized before it published the Draft EIS that plans for a repository would continue to evolve during the development of any final repository design and as a result of any licensing review of the repository by the Nuclear Regulatory Commission. The design evolution was evaluated in the Supplement to the Draft EIS and integrated into the Final EIS. The Supplement incorporated new information, including an improved understanding of the interactions of potential repository features with the natural environment, the addition of design features for enhanced waste containment and isolation, and evolving regulatory requirements.

Although the waste package and repository designs will continue to evolve in response to additional site characterization information, technological developments, and interactions with oversight agencies, DOE believes the designs have progressed to a point that they provide a reasonable basis for estimating the range of potential short- and long- term impacts that would likely result from any final designs. Furthermore, it not unusual for an agency to assess design alternatives that are in the conceptual phase under the National Environmental Policy Act. The consideration of only a final design could, on the other hand, preclude or bias an agency's flexibility to structure a Proposed Action that could be less intrusive on the environment.

The design of the waste package, including its construction materials, has evolved from the Draft EIS design to the current flexible design. While both use a two-layer waste package, the flexible design places the corrosion-resistant material on the outside rather than the inside of the package to provide long-term protection to the more corrosion-susceptible structural material. The current waste package design includes a thick and very corrosion-resistant nickel-base alloy (Alloy-22) as the outer barrier over a thick stainless-steel inner liner. Data on the corrosion performance of the waste package materials (including the internal structure) have been collected from DOE tests and from research literature. Testing would continue during waste emplacement and preclosure to collect long-term data under conditions prototypical of those expected at Yucca Mountain. The data generated will continue to go to the analysts who determine the long-term performance of the materials as a part of the determination of total system performance in compliance with regulatory standards.

DOE based the development of models that predict the performance of corrosion-resistant, nickel-based Alloy-22 in the repository on data from research literature and testing (including long- and short-term tests). DOE performs long-term tests under expected repository conditions, and short-term tests under expected repository conditions and very aggressive conditions. The American Society for Testing and Materials codified this approach in a standard procedure (DIRS 105725-ASTM 1998). Analyses of the tests use a suite of tools, including standard microstructural evaluation and atomic force microscopy, which permits the examination of surface films in such great detail that

DOE can evaluate even very slow degradation rates. DOE will continue to test samples of Alloy-22 and other alloys that would be exposed in the repository and in the laboratory for decades to confirm the results collected to date. In addition, DOE will explore analogs of Alloy-22 to provide confidence in its performance.

DOE based the materials selection on the input of independent experts and laboratory tests, and from material performance observed in full-size industry applications. The corrosion tests involve Alloy-22 and other candidate waste package materials subjected to environments that are at least as aggressive as any expected inside Yucca Mountain. These tests would continue during waste emplacement operations to confirm the expected waste package performance.

DOE acknowledges that it cannot build a waste package that can be guaranteed to provide perfect containment forever. The EIS provides DOE's best estimate of the impacts that would occur when the containment system degraded. The Environmental Protection Agency, in promulgating the Yucca Mountain environmental protection standards (40 CFR Part 197), recognized that with the current state of technology it is impossible to provide a reasonable expectation that there will be "zero" releases over 10,000 years or longer time frame. Therefore, the Agency promulgated standards that it believes would protect human health and safety. These standards do not require complete isolation of the wastes over the compliance period (10,000 years) or the period of geologic stability (1 million years). The goal of a performance assessment for Yucca Mountain supporting the site recommendation decision and later licensing (if the site was recommended and approved) is to evaluate whether the repository would be likely to meet these standards. The goal of this EIS is to project possible impacts using similar modeling technology. The results of these efforts, as described in Chapter 5 of the EIS, show that releases under the Proposed Action would not exceed environmental protection standards (40 CFR Part 197) within the 10,000-year compliance period for the repository.

7.1 (10574)
<u>Comment</u> - EIS002131 / 0003
And there has been some talk about how good dry cask technology is. Here's the New York Times article. It says: "To maximize the chance that they will stay intact for thousands of years, the stainless steel is handled only by machines or by gloved hands because the chemists say that even the salt on sweaty palms would begin to corrode the stainless steel, which is three-eighths of an inch thick," and this is supposed to last a half a million years, and just it will corrode from the salt on your hand.

<u>Response</u>
The proposed repository, as described in the Supplement to the Draft EIS, would include a robust engineered barrier system designed specifically to work with the favorable natural barrier system at Yucca Mountain. The current design includes a robust and corrosion-resistant waste package and a titanium drip shield above each waste package for defense-in-depth against corrosion. Structural steel used for ground support in the drifts and the titanium drip shields would protect the waste packages against rockfalls.

The design of the waste package described in the Supplement and carried forward to the Final EIS includes a very corrosion-resistant, nickel-base alloy (Alloy-22) as the outer barrier over a stainless-steel inner structural liner. The purpose of the stainless-steel wall is to provide structural strength and resistance to corrosion. For added conservatism, the long-term performance assessment models assumed no barrier credit for stainless-steel components.

DOE conducted an extensive process to identify suitable materials for the waste package; this selection process continues to evolve. Material selection involved evaluating each waste package component and function, selecting commonly available materials that have characteristics that meet the functional requirements, rating materials, and testing materials. DOE completed the analysis by selecting weighting criteria and establishing grading scales. Weighting criteria included mechanical performance, chemical performance (corrosion), predictability of performance, compatibility with other materials, ease of fabrication, cost, previous industrial experience, thermal performance, and neutronic performance. Testing would continue during waste emplacement and preclosure to collect data under conditions expected at the repository. The data generated would continue to be analyzed to determine the long-term performance of the materials.

The container cited in the comment is built of thin-walled stainless steel. This is very different from the robust design of the waste package, which would have a thick nickel alloy outer wall in addition to a stainless-steel inner wall. Section I.5.1 of the Final EIS describes the results of computer analyses of the behavior of the waste package under a range of environmental conditions.

7.1 (11115)
Comment - EIS001207 / 0004
Has the Yucca Mountain Site Characterization Office determined the package design (can in canisters filled with borosilicate glass containing intensely radioactive high-level waste) to be acceptable/suitable for disposal? Has this technology been deemed to meet performance standards? How and when were performance/can-in-canister design standards tested and approved? During what time period of the Yucca Mountain Site operations are there can-in-canisters anticipated to fail/leak?

Response
Waste package designs evaluated in the Draft EIS were summarized in Section 2.1.2.2.2 and shown in Figure 2-20 of the Draft EIS. One or two high-level radioactive waste canisters containing immobilized plutonium, the so-called "can in canister," would be placed along with other glass high-level radioactive waste canisters inside a waste package such that five high-level radioactive waste canisters are arranged as a ring inside the waste package. A canister of DOE-owned spent nuclear fuel can be placed in the center of the ring. The walls of the waste package analyzed in the Draft EIS would consist of a thick carbon-steel barrier surrounding a thick barrier of Alloy-22, a highly corrosion-resistant nickel-chromium-molybdenum alloy.

The design of the waste package, including its construction materials, has evolved from that used for the Draft EIS design to the current flexible design. While both use a two-layer waste package, the flexible design places the corrosion-resistant material on the outside rather than the inside of the package to provide long-term protection to the more corrosion-susceptible structural material. The current waste package design includes a very corrosion-resistant nickel-based alloy (Alloy-22) as the outer barrier over a thick stainless-steel inner liner. Data on the corrosion performance of the waste package materials (including the internal structure) have been collected from DOE tests and from research literature. Testing would continue during waste emplacement and preclosure to collect long-term data under conditions prototypical of those expected at Yucca Mountain. The data generated will continue to go to the scientists and engineers who determine the long-term performance of the materials as a part of the determination of total system performance in compliance with regulatory standards.

To determine the long-term performance of the repository, a modeling system called Total System Performance Assessment was used. The Total System Performance Assessment is a simulation of the performance of the entire repository system after closure. The Total System Performance Assessment is a probabilistic simulation; that is, it directly incorporates ranges of uncertainty in parameters and reports the possible range of results. The mean value of the range is what is used to determine compliance with environmental protection standards. In the case of waste package degradation, a very conservative wide range (several orders of magnitude) of possible degradation rates (centered on values obtained from testing as described above but also including some much higher pessimistic values) are simulated in the analysis which includes up to 300 trials during which the full range of possible values is sampled. The results of these simulations for the flexible design, described in Chapter 5 of the Final EIS, indicate that penetration of high-level radioactive waste canisters containing immobilized plutonium would not occur until after the waste package had been breached. Failures would be unlikely during the first 10,000 years.

7.1 (11919)
Comment - EIS002303 / 0004
For very long term storage of unusually hazardous materials, why not use containers with a geologically relevant lifespan? Glass has a potential lifespan of MILLIONS of years, comparable to the hazard life plutonium and related waste represent. Recycled glass, as compared to quartz or ceramic, is cheap, plentiful and easy to work with. Higher grade materials could be used, but a multi-layer, mechanically isolating design should be adequate.

Intruding groundwaters will not corrode steel barrels, if they are encapsulated with a Long Life Chemically Resistant Toxics Container.

Kevlar woven glass is tough and chemically resistant, and can encapsulate the waste for the geologically relevant time frame required. Glass provides long term mechanical isolation for the inner layer(s). More than two solid glass layers could be used. An inner PTFE (Teflon) coating provides a reserve seal.

Response
Selection of materials for the waste package is based on several factors, not just corrosion resistance. The waste package must be able to withstand significant static loads and shocks (dynamic loads). It must have good thermal conductivity to transmit the heat generated by the nuclear waste. When the waste package was loaded with waste, the final seal would have to be just as strong, ductile, and corrosion-resistant as the rest of the waste package.

Glasses are inferior for nuclear waste containment compared to corrosion-resistant metal alloys for the following reasons: (1) poor fracture toughness and ductility, (2) low thermal conductivity, (3) difficulties associated with fabrication and sealing of large waste packages, and (4) lack of thermodynamic stability to retain the material composition and microstructure. In addition, the ability of glass to withstand elevated temperatures and intense gamma radiation is not as well understood as that of many metal alloys.

DOE continues to research the ability of different materials to contribute to the isolation of nuclear waste. Alloy-22, the waste package material currently considered most suitable for the repository, offers excellent resistance to corrosion, is relatively easy to manufacture, is able to transfer heat effectively, and is able to survive handling and hypothetical accidents.

7.1 (12744)
Comment - EIS001888 / 0431
[Clark County summary of comments it has received from the public.]

Commenters wanted the EIS to address the abilities of the waste packages to contain SNF and HLRW (for thousands of years, forever, until full decay has occurred, how long?) given thermal dissipation requirements, radioactive bombardment, photo disintegration, nuclide release rates, failure under earthquake-induced stress, and other natural hazards. A commenter requested that the EIS select manmade and natural materials that will retard the movement of radionuclides for placement in the near-field around the waste packages.

These materials were requested to reduce uncertainties associated with the retardation potential of the host rock and to be consistent with DOE's suitability guidelines and the U.S. Nuclear Regulatory Commission's regulations, both of which call for "multi barrier" concepts. Another commenter requested that the EIS provide a description of engineered features that would provide adequate containment of C12 for 10,000 years, without reliance on natural barriers. One commenter requested a discussion of the measures that would ensure the integrity of repository seals, as well as any other barriers to permanently separate the waste from the environment.

Response
The purpose of any design scenario would be to delay or disrupt the potential release of radioactivity. The objective of the repository (both engineered and natural barriers) would be to minimize dose at the accessible environment. The repository would rely on delaying and restricting releases to achieve this objective. The design scenarios DOE has considered would reduce dose rates at the accessible environment by retarding the migration of radionuclides or by delaying the earliest time at which they could migrate, thereby allowing most of the radioisotopes to decay to stable elements.

Carbon-12 is a stable isotope of carbon. Carbon-14 is a radioactive isotope present in spent nuclear fuel. Carbon-14 has a half-life of approximately 5,700 years, meaning half of a given inventory of carbon-14 decays to stable nitrogen-14 within 5,700 years. The waste packages are expected to outlive most of the carbon-14. DOE also expects that most of the fuel rods in the waste packages would have intact cladding, which would further delay the release of carbon-14 and therefore provide additional time for carbon-14 to continue to decay.

Various aspects of the natural system would retard the migration of radionuclides and delay the earliest time at which radionuclides could migrate. The analyses in the EIS do not identify potential impacts that would be a basis for not proceeding with the development of Yucca Mountain as a repository.

While the Nuclear Waste Policy Act of 1982 mentions waste isolation, because of the long periods involved (10,000 years or more), permanent, complete isolation of the waste from the habitable environment is not realistic for any site. However, the Nation still must address the disposal of existing radioactive waste. Therefore, the EIS discusses this goal in achievable terms of limiting the release rate and transport of radionuclides to the environment. Reliance on the natural barriers provided by the rock, dry climate, and remoteness of the site, as well as the additional engineered barriers, would minimize the potential dose rate to the accessible environment to within regulatory guidelines defined by the Environmental Protection Agency and the Nuclear Regulatory Commission. The purpose of the regulations prepared by the Agency (49 CFR Part 197) and the Commission (10 CFR Part 63) is to implement the policy stated in the Nuclear Waste Policy Act, and both regulations recognize the validity of this approach.

The *Viability Assessment for a Repository at Yucca Mountain* discusses sealing materials and placement methods for closure and sealing of shaft, ramps, and boreholes (DIRS 101779-DOE 1998). DOE does not plan to backfill the emplacement drifts, but has not precluded it as a potential future design option.

7.1 (13290)
Comment - 010068 / 0002
The corrosion of the proposed alloys in recent news seems to have been missed in the DEIS. The attractiveness of certain alloys is not factored into the human intrusion scenarios. Expensive alloys used to protect the waste would be a lure for human intrusion. Titanium can increase in cost and attractiveness to human intrusion. Titanium is used in drip shields.

Response
The behavior of Alloy-22 and the titanium alloy has been studied extensively for the project and very recent experimental data have been incorporated into the waste package and drip shield degradation models. Additional information can be found in Appendix I of the Final EIS and various supporting documents referenced therein.

Under the advice of the National Research Council of the National Academy of Sciences, the Environmental Protection Agency elected to exclude considerations of deliberate human intrusion from the final repository performance standard (40 CFR Part 197). This is because it is impossible to characterize with any degree of certainty the range of deliberate acts of humans in the future and also because of the long period of administrative control. Therefore, such considerations as the value of materials of construction in the repository are not within the scope of the long-term performance analyses.

However, consistent with requirements, DOE evaluated the potential impacts of an inadvertent human intrusion; the results are summarized in Section 5.7.1 of the EIS.

7.1.1 DRAFT EIS REPOSITORY DESIGN

7.1.1 (73)
Comment - 3 comments summarized
Commenters were concerned that DOE did not know what type of ground support would be used in the emplacement drifts. Some wanted to know if any supports had been tested. Others noted that steel, concrete, rockbolts, and mesh all have problems, and suggested that other materials be examined.

Response
The ground support methods and materials are based on many years of experience and testing in the mining industry. Additional specific experience has been gained through testing of ground supports conducted at Yucca Mountain for many years in the Exploratory Studies Facility (see Section 2.1.2.2.4.2 of the EIS for more information on ground supports). The reference design of the subsurface facilities on which DOE based the Draft EIS analyses has evolved. The current design includes an all-steel ground support system (welded wire, tie rods, steel sets) rather than concrete liners. The Final EIS evaluates and explains the rationale for design enhancements. To provide updated information to the public, DOE published a Supplement to the Draft EIS that focused on the most recent design enhancements.

The subsurface facility design is still evolving under the direction of DOE. The Department would ensure that the facility and equipment designs, including the drift lining, meet all design requirements, receive the necessary peer reviews, and receive Nuclear Regulatory Commission review and approval prior to licensing of the proposed repository.

7.1.1 (74)
Comment - 6 comments summarized
Commenters were concerned that the waste packages would not be retrievable after being emplaced in the drifts. Some said that retrieval equipment would fail and block further retrieval efforts. Others questioned whether it was accurate for the EIS the consider retrieval to be simply the reverse of emplacement. Commenters suggested that a few waste packages should be retrieved each year to ensure that retrieval, if required, could be accomplished. Commenters pointed to problems with the Ventilated Storage Cask, Model 24 in current use for dry storage and said similar problems could occur at the repository. Commenters also noted several other possible problems including weld problems, unexpected emissions, stuck shims in the lid, overhead trolley problems, and the movement of casks over other casks in the emplacement drift. Some commenters said that detailed procedures for retrieval should be developed.

Response
Current conceptual designs assume the equipment used for retrieval would be the same equipment used for emplacement. As a consequence, maintenance and operation of this equipment during emplacement would provide extensive experience before any retrieval. The current concept would not involve lifting one waste package over another; retrieval would be accomplished by moving one waste package at a time starting at the end of the drift and moving toward the center. Empty drifts would provide staging for waste packages that did not need to be retrieved but only moved. The reliability of the retrieval process is based on having the capability to retrieve from either end of a drift and having multiple gantry vehicles available at either drift entrance to retrieve waste packages. Based on many years of experience in mines, small rockfalls would not preclude operation of the gantry for retrieval; the ground support system would protect against large rockfalls. However, in the event that a drift became blocked during retrieval, the operation could be continued through the other drift entrance with other equipment.

DOE is evaluating periodic removal of emplaced waste packages for performance evaluation in the design.

The subsurface facility design is still evolving under the direction of the DOE. The Department will ensure that the facility and equipment designs meet all design requirements (including development of adequate maintenance programs) and receive the necessary peer reviews. In addition, the Nuclear Regulatory Commission must review and approve all repository design and operational plans prior to licensing of the proposed repository.

7.1.1 (430)
Comment - EIS000080 / 0001
Nye County is a proponent of alternative repository design, including natural ventilation. We believe that that will lead to a safer repository, and a safer repository is Nye County's number one concern.

Response
DOE has considered alternative design concepts in the EIS, including natural ventilation. Sections 2.1.4.1 and E.2.2.5 of the EIS provide more information on this topic.

The latest repository design described in the Supplement to the Draft (released for public review in May 2001) and the Final EIS has the flexibility to accommodate and take advantage of new information that might improve performance or reduce long-term uncertainties.

7.1.1 (431)
Comment - EIS000080 / 0002
Nye County is a proponent of active groundwater controls. We don't see any concept being put forth by DOE to go in and improve the suitability of the site.

We routinely go in and [de-water mines in] the State of Nevada because of the water below the ore piles. No one's talking about going in and decreasing the water level underneath Yucca Mountain. We see that as a viable mitigating measure that increases the distance between the waste and the water resources.

Response
Groundwater pumping to lower the water table can be a viable means for dealing with short-term contamination issues at mines. However, it is not a viable option for a geologic repository that would have to meet regulatory compliance limits for 10,000 years. Before closure, the waste packages would remain intact and there would be no radioactive releases. So lowering the water table to increase the travel time from the waste emplacement areas to the saturated zone would not be an issue. After closure, the passive components of the system, comprised of engineered and natural barriers, have been designed to provide long-term protection to people and the environment by demonstrating compliance with both Environmental Protection Agency and Nuclear Regulatory Commission environmental protection standards.

7.1.1 (754)
Comment - EIS001337 / 0081
Page 2-65 Section 2.2.2.2. The assumption of 10,000 years of institutional control seems inconsistent with NRC [Nuclear Regulatory Commission] licensing guidance which encourage licensees to not assume institutional control beyond 300 years. This scenario should be revised to assume institutional control for 300 years (which is also consistent with the Preferred Alternative for Yucca Mountain).

Page 2-66 Section 2.2.2.3. The assumption of loss of institutional control after 100 years is not consistent with NRC licensing guidelines nor with assumptions associated with the Preferred Alternative (institutional controls at Yucca Mountain for 300 years). No-Action Scenario 2 should be deleted from the DEIS.

Response
Because the future course of action taken by the Nation and by commercial utilities would be uncertain if Yucca Mountain was not recommended as a repository site, the No-Action Alternative evaluated two hypothetical scenarios with different assumptions about institutional control to provide a range of impacts that could occur and to provide a basis for comparison to the Proposed Action.

The assumption for Scenario 1 is that DOE and commercial utilities would maintain institutional control of the storage facilities to ensure minimal releases of contaminants to the environment for at least 10,000 years. Although both the Nuclear Regulatory Commission and the Environmental Protection Agency encourage the maintenance of monitoring and physical oversight for as long as possible, they have recognized that projecting society's willingness and ability to provide such a function for more than 100 years into the future is not reasonable. For this reason, Scenario 2 assumes no effective institutional control after approximately 100 years. DOE based the choice of 100 years on a review of Environmental Protection Agency regulations for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain (40 CFR Part 191), Nuclear Regulatory Commission regulations for the disposal of low-level radioactive material (10 CFR Part 61), and the National Research Council report on standards for the proposed Yucca Mountain Repository (DIRS 100018-National Research Council 1995), which generally discount the consideration of institutional control for longer periods in performance assessments for geologic repositories. Assuming no effective institutional control after 100 years provides a consistent analytical basis for comparing the No-Action Alternative and the Proposed Action.

7.1.1 (2648)
Comment - EIS000409 / 0006
Designs for the Repository itself: There are no concrete plans for one much less two repositories. The application of real or artificial barrier systems are still in the conversational stages. Where & how would the canisters be stored (hot, hot) temporarily until the cave is burrowed out? The International Nuclear Industry is waiting and watching carefully to see how fast we can succeed in blowing ourselves up. All of the extrapolations done by our famous DOE physicists will mean nothing because there is no DOE policy on how long the mountain would remain open or how many years it would take to fill (1 or 2). The law says you cannot close the mountain until it is filled.

Again the only answer is transmutation and recycling by our business trained trillionaires. Projected cost for 1 repository $35 billion.

Response
Until a repository is licensed and prepared to receive spent nuclear fuel and high-level radioactive waste, the Department believes that these materials will continue to be stored at the generator sites. However, other options

have been evaluated, including a proposed interim storage facility in Utah (DIRS 152001-NRC 2000). In addition, the updated flexible design includes provisions for aged storage at Yucca Mountain for up to 40,000 metric tons heavy metal of commercial spent nuclear fuel to support the low-operating temperature operating mode. However, onsite storage of spent nuclear fuel at the Yucca Mountain site would not be allowed until after the Nuclear Regulatory Commission issued an operating license, which would not be expected before the year 2010.

The scope of the EIS is limited by the NWPA to the consequences of a single repository at Yucca Mountain (the Proposed Action) compared to the consequences of storing the waste indefinitely at commercial and DOE sites around the country (the No-Action Alternative). The amount of waste that DOE could place in the repository is restricted by the NWPA to 70,000 metric tons of heavy metal until a second repository is in operation. DOE is not scheduled to report to Congress on the need for a second repository until 2007.

DOE believes that the design of the engineered barrier system described in the Supplement to the Draft EIS (released for public review in May 2001) is sufficiently developed to allow DOE to estimate the long-term environmental consequences of the repository. As discussed in Section 2.1.2.1.1 of the Final EIS, waste would be unloaded from transportation casks and repackaged in waste packages for emplacement in the repository; storage at the surface would not extend over long periods.

Section 122 of the NWPA requires retrievability at a high-level radioactive waste repository. Federal regulations (10 CFR Part 63) require that the repository be designed to preserve the option of waste retrieval on a reasonable schedule for as long as 50 years after the start of waste emplacement. Consistent with these requirements, the operational plan for the Yucca Mountain repository provides for a design and management approach that isolates wastes from the public in the future while allowing flexibility to preserve options for modifying emplacement and retrieving the waste. This design would maintain the ability to retrieve emplaced materials for at least 100 years and possibly as long as 300 years or more in the event of a decision to retrieve the waste either to protect the public health and safety or the environment or to recover resources from spent nuclear fuel. DOE examined closure dates ranging from 50 to 300 years after initial emplacement and has determined that any closure date within this range would not significantly affect the environmental consequences of the repository, especially when comparing the Proposed Action to the No-Action Alternative.

There is no law stipulating that the repository must remain open until it is “filled,” only restrictions on the maximum amount of waste that can be emplaced and the minimum duration for the retrieval period.

With regard to transmuting or recycling nuclear waste, DOE acknowledges that new technologies for waste management could be developed in the future. In fact, at the direction of Congress, DOE is studying accelerator transmutation of radioactive waste. The process involves state-of-the-art principles, some of which are not yet proven. However, even if accelerator transmutation becomes a feasible technology, a repository is an essential element of the nuclear fuel cycle because significant quantities of highly radioactive, long-lived materials would remain. Therefore, DOE does not recommend abandoning the Nation’s current waste management strategies.

7.1.1 (4166)
Comment - 010034 / 0001
It is obvious that there is little or no attention being given to accidents, electrical or mechanical malfunctions. In the event of these unforeseen incidents there very well might be a short isolation period followed by a fast, uncontrolled release. This could be caused by a seismic event or an electrical failure shutting down the ventilation now required to lower the temperature and dissipate the unexpected humidity and moisture. This same humidity moisture is corrosive, containing brine and microorganisms.

Would human beings be able to enter the tunnel to retrieve these waste packages in the event the train and/or gantry malfunctioned? How can the DOE depend on robotics when there has been little attention given to accidents and malfunctions? If there is backup power to the project is there enough to fully operate all electrical machines and other equipment? It was mentioned that brine and microorganisms would degrade the waste packages made up of titanium and stainless steel. What attention has been given to the corrosive effects on the electrical and mechanical systems? For example, rails, switches, circuit breakers, wire connections or metal less able to resist corrosion than titanium or stainless steel?

It is obvious that since the tunnels will be open for 300 years to assure retrievability of the waste packages, that an accident or malfunction will make this impossible.

Response
Humans would not be able to enter an emplacement drift once it has been loaded with waste packages without the use of thermal and radiation shielding. DOE has developed plans for waste package retrieval for normal and off-normal conditions. Waste package retrieval under normal conditions would use the same subsurface equipment and facilities as emplacement, but in reverse order. This would provide a built-in capability for retrieval that could be readily implemented. Individual waste package removal for inspection, testing, and maintenance reasons would not be retrieval; however, waste package removal for these purposes, if needed, would involve the same equipment and operational steps. Alternative waste package equipment and processes have been identified for off-normal conditions when normal retrieval procedures could be different or impossible to execute. In addition, support equipment (equipment to remove obstacles, prepare surfaces, or install temporary ground supports) that could be used in retrieval operations under off-normal conditions has been identified. The equipment and processes would support various scenarios such as repair of the railing system, repositioning the emplacement pallet and waste package, or cleaning or removal of debris. All retrieval scenarios include establishment of radiation and temperature controls and other administrative controls, as needed, to conduct a safe retrieval operation (DIRS 153849-DOE 2001). During the preclosure period, which could last up to more than 300 years, the repository will be open and subject to inspection and maintenance. Should problems with corrosion of rails, switches, etc. be detected, repairs and/or replacements would be made.

7.1.1 (4266)
Comment - EIS001521 / 0025
Page 3-30, first paragraph--In this paragraph, fault displacements are related to the layout design of the central block of the repository. It does not appear that the same consideration was given to the design of the l-t-l expansion blocks (especially the westward extension). If it was, it should be mentioned in the text.

Response
There are little site characterization data available for a potential expansion zone west of Solitario Canyon. DOE would not have to expand into that area until the central repository block was full or if space was needed to accommodate more than 70,000 metric tons of heavy metal. There would be ample time (30 to 40 years) to characterize the expansion area in detail before it was needed. An expansion of storage capacity to accommodate more than the 70,000 metric tons of heavy metal authorized in the NWPA would require the operation of a second repository or a Congressional amendment to the Act.

7.1.1 (4564)
Comment - EIS001521 / 0078
Page 4-99, Figure 4-5--Where is the location of the waste-retrieval and storage area with reference to Midway Valley? The referenced page 3-34, Figure 3-12, shows the location of Midway Valley (sort of) but the actual location of the waste retrieval and storage area is still unknown.

Response
One of the alternative sites for the Retrieval Facility is in Midway Valley near the repository site. DOE has not yet determined the design of this facility or its exact location. The Department believes that the information in the EIS is adequate for determining representative environmental impacts of using this site for waste retrieval.

7.1.1 (4968)
Comment - EIS001326 / 0002
I also recommend telling the U.S. what measures you are taking to be positive that the nuclear waste you are disposing of will not leak into the environment.

Response
The repository would include an engineered barrier system designed specifically to work with the natural geologic and hydrologic barriers at the site. The engineered barrier system is described in the Supplement to the Draft EIS (released for public review in May 2001) and the Final EIS. This system includes a robust and corrosion-resistant waste package and a titanium drip shield above each waste package for defense-in-depth against corrosion.

Structural steel used for ground support in the drifts and the drip shields would protect the waste packages against rock fall. Based on analyses in Chapter 5 of the EIS, the engineered and natural barriers at the site would provide waste isolation in compliance with the standards in 40 CFR Part 197. These analyses show that the waste would be isolated for tens of thousands of years. Confirmatory testing would continue during the emplacement and preclosure periods to collect long-term data under conditions typical of those expected at Yucca Mountain after closure.

7.1.1 (5356)
Comment - EIS001887 / 0077
Page 2-16; Section 2.1.2.1.1 - North Portal Operations Area

It should be pointed out that the design of this part of the repository surface facility, including the buildings and operations in the restricted area, is preliminary and, at best, conceptual. DOE has not even finally decided (contrary to information in the Draft EIS) whether the Waste Handling Building will employ the use of waste transfer pools or use hot cells exclusively.

The Draft EIS fails to adequately describe and evaluate impacts of specific types of facilities needed to receive, package, and handle spent fuel and high-level waste for disposal. The Draft EIS attempts to avoid specific analyses by indicating that the nature of such operations would depend on how the spent fuel is packaged for transport. Nevada contends that the information currently exists for DOE to clearly identify specific operational requirements and to discriminate among alternatives for operations at the North Portal facilities. However, this requires a more adequate, substantive, and site-specific analysis of spent fuel and HLW at reactor and generator facilities and the specific modes to be used for shipment from each site. Such an assessment is clearly within the technical capabilities of DOE and within the appropriate scope of the Draft EIS. DOE should be able to identify, with considerable certainty, the type of package that would be received at the North Portal from each reactor/generator site. With that information, DOE can then specify, in considerable detail, the actual facilities and activities required at the North Portal area. Such a detailed description is needed in order to conduct an adequate assessment of risks and impacts.

Such an analysis would also help to clarify the differential risks and attendant mitigation associated with various handling scenarios. For example, if the analysis showed that a large percentage of the waste would arrive at the North Portal operations area as uncanistered spent fuel (as is very likely, given the market-driven transport system being planned by DOE and commercial utilities), the North Portal Operations Area and facility needs would be considerably different than they would be if most of the waste arrived in dual or multi-purpose canisters.

Response
Because of the evolving nature of the design of the repository, DOE issued a Supplement to the Draft EIS in May 2001 for public review. This Supplement describes the impacts of the repository based on the most recent repository design. This design information was carried forward to the Final EIS. DOE believes that these impact analyses would adequately bound the impacts from any additional changes in the design of the repository.

DOE is developing waste acceptance criteria for the repository. Some shipments could contain failed fuel and radioactive nonfuel components in special packages. A variety of defense waste forms include spent nuclear fuel and defense high-level radioactive waste shipped in canisters that can be directly placed in disposable waste packages at the repository.

The waste handling systems at the repository would be able to handle a diversity of casks, canisters, and waste forms; open casks and canisters; and package the waste for disposal. The systems would concurrently handle waste in disposable canisters and bare fuel (the assembly transfer and canister transfer systems). The systems and facilities would also handle abnormal and damaged waste forms, damaged waste packages (the waste package remediation system), and a facility for maintaining shipping casks to license requirements.

DOE made full use of the waste form characteristics, and the system and facility designs previously described to ensure that it considered the range of environmental impacts of the monitored geologic repository, as described in Section 4.1. Also included are the environmental impacts for three additional scenarios, the all legal-weight truck scenario, the mostly disposable canister scenario (canisters designed for direct insertion into a waste package), and the mostly dual-purpose canister scenario. Facility and system designs have not been developed for these cases. However, the monitored geologic repository facility, site staffing, and waste form were factors that were included in the analysis of the potential environmental impacts. The same detail of information is provided in the Supplement to the Draft EIS for the latest changes in the design of the repository. This updated design information is carried forward to the Final EIS.

DOE performed an analysis to classify the various systems for their importance to safety. The Department is performing preliminary hazard and design-basis event analyses to determine the hazards associated with equipment failures and events that would be used to determine if additional design and safety features are required.

7.1.1 (5361)
Comment - EIS001887 / 0079
Page 2-21; Sections 2.1.2.1.3 and .4 - Ventilation Shaft Operations Area

The Draft EIS does not describe the method to be used for ventilation shaft construction and does not appear to describe the environmental impacts specific to shaft construction. Section 4., Section 2.1.2.2.1, Subsurface Facility Design and Construction, implies that the shafts are not planned to be constructed by drill-and-blast. This should be clarified.

Response
The Final EIS has been revised to state that the vertical ventilation shafts would be excavated by mechanical means (for example, vertical mole, drilling, and raised boring) or by drill-and-blast techniques (DIRS 153849-DOE 2001). Additional information related to various excavation techniques may be found in DOE (DIRS 153849-2001).

The impacts to air quality from this and other construction activities are addressed in Section 4.1.2 and in the Supplement.

7.1.1 (5364)
Comment - EIS001887 / 0082
Page 2-27; Section 2.1.2.2.1 - Subsurface Facility Design and Construction

Concrete liners are no longer part of the repository design. An accurate, current description of the repository design should be included in the Draft EIS.

Under what circumstances and in what manner would waste packages be moved over other waste packages? Does the technology exist at this time to do this? Have scenarios where waste packages are dropped on other waste packages been evaluated? The Draft EIS should include a discussion of this aspect.

Response
Because of the evolving nature of the design of the repository, DOE issued the Supplement to the Draft EIS in May 2001 for public review. The current design for the emplacement drifts includes an all-steel ground support system (welded wire, tie rods, steel sets, rock bolts), rather than concrete liners. The Supplement evaluates and explains the rationale for these design enhancements and this information was carried forward to the Final EIS. The current design, as well as the design examined in the Draft EIS, does not include the lifting of a filled waste package over other waste packages.

7.1.1 (5365)
Comment - EIS001887 / 0083
Page 2-31; Section 2.1.2.2.1 - Subsurface Facility Design and Construction

Water usage during site characterization and the construction of the ESF was not adequately monitored, evidenced by the multiple quality assurance findings and nonconformance reports written about the tracking of water usage. What other controls would DOE use to ensure that water used during construction of the repository would not affect repository performance?

<u>Response</u>
During construction of the Exploratory Studies Facility, it was very important to monitor and limit the use of water because scientists did not want to disturb the natural environment of the mountain before they could measure the natural ambient conditions. Water use during construction of the repository for such things as dust suppression would not be as critical because the site characterization work would have been completed.

Potential impacts to surface water from construction, operations, maintenance, monitoring, and closure of the repository are discussed in Section 4.1.3.2 of the EIS. Water used in the subsurface areas during construction would be pumped to a lined evaporation pond at the South Portal Operations Area. Water collected from the emplacement areas, if any, would be pumped to a lined evaporation pond at the North Portal Operations Area.

7.1.1 (5413)
<u>Comment</u> - EIS001887 / 0116
Page 2-57; Section 2.1.4.1 - Design Features and Alternatives to Limit Release and Transport of Radionuclides

Of the five design features listed in the category "Barriers to limit release and transport of radionuclides" in Table 2-4, only one -- additives and fillers -actually serves to limit release and transport of radionuclides. The remaining four, drip shields, backfill, waste package corrosion-resistant barrier, and ground support options serve only to delay releases and do not eliminate or substantially reduce releases of radionuclides, the true measure of repository performance. The ideal goal of repository performance is to eliminate the potential for release of emplaced radionuclides. The realistic objective is to limit releases, at whatever time they occur, to acceptable levels. The Draft EIS analysis indicates that a Yucca Mountain repository cannot meet this objective, relative to expected peak doses resulting from released radionuclides after the short period of time (300 to 1,000 years) during which the major fission products decay. Juvenile failure of components of the engineered barrier system could result in radionuclide releases prior to the time major fission products have decayed to very low levels.

Many of the features and alternatives discussed in this section and elsewhere in the Draft EIS are actually part of DOE's current design for a Yucca Mountain repository. As such, the impacts of these features and alternatives should have been fully addressed in the Draft EIS. For example, the current repository conceptual design (not the design described in the Draft EIS) calls for the waste packages to be covered by a continuous titanium drip shield. The Draft EIS should examine the impact on the national (and perhaps international) titanium resource from the increased demand caused by the use of titanium drip shields in up to 100 miles of repository tunnels.

<u>Response</u>
DOE recognizes that some radionuclides and potentially toxic chemicals would, after more than 10,000 years, enter the environment outside the repository. The design alternatives described in the EIS would delay the potential release of radioactive contaminants from the repository. As noted in Section 5.4.1 of the EIS, DOE expects the rate of early failures of waste packages to be very low; too low to have meaningful consequences on the long-term performance of the repository. Based on the results of analyses reported in Chapter 5 of the EIS concerning the long-term performance of the repository, DOE believes that a repository at Yucca Mountain would operate in compliance with the radiation protection standards in 40 CFR Part 197.

Because of the evolving nature of the design of the repository, DOE issued a Supplement to the Draft EIS in May 2001 for public review. The enhanced design discussed in the Supplement would improve long-term repository performance and reduce some of the uncertainties associated with this performance. Enhancements include a more corrosion-resistant waste package and titanium drip shields over each waste package. The Supplement describes the impacts of the repository based on the most recent repository design. DOE believes that the impact analyses in the Supplement would adequately bound additional impacts that could result from further enhancements in the design of the repository.

As described in Section 4.1.15 of the EIS, the annual requirement for titanium for drip shields ranges from about 4,300 to 6,500 metric tons (4,700 to 7,200 tons) depending on the operating mode and packaging scenario. The magnitude of the comparison is the result of low U.S. production of the basic raw material, because the United States imports most of the titanium raw material. Although the annual U.S. production of titanium raw material is only 21,600 metric tons (23,800 tons), the annual U.S. capacity to produce titanium ingots is 78,200 metric tons (86,200 tons) (DIRS 152457-Gambogi 1997). The maximum annual program need is a little more than 8 percent of the current annual U.S. ingot production. Titanium is classified as a Federal Strategic and Critical Inventory material and is the ninth most common element in the Earth's crust (DIRS 107031-U.S. Bureau of Mines 1995). Because the drip shields would not be needed until repository closure, there would be adequate time (more than 100 years) to expand the production of titanium raw material or to import additional raw material before the need to reduce impact on markets.

7.1.1 (5485)
Comment - EIS001887 / 0155
Page 3-24; Section 3.1.3.1 - Physiography (Characteristic Landforms): Selection of Repository Host Rock

The discussion on the repository host rock should indicate that, during construction of the ESF, more significant ground support methods than originally expected were required to achieve "stable openings."

Response
During construction of the Exploratory Studies Facility, portions of the North and South Ramps needed ground support. However, ground support at the repository level (where the waste would be emplaced) was minimal; the openings were very stable. DOE believes that the existing text is adequate.

7.1.1 (5584)
Comment - EIS001887 / 0209
Page 4-3; Section 4.1 - Short-Term Environmental Impacts of Performance Confirmation, Construction, Operation and Monitoring, and Closure of a Repository

The text states that closure would include "Potentially backfilling the main drifts, access ramps, ventilation shafts, and connecting openings." This is not fully consistent with the description of closure in Section 2.1.2.3, Repository Closure. That section states closure would include, "filling of the main drifts, access ramps, and ventilation shafts; and sealing of openings, including ventilation shafts, access ramps, and boreholes." These two statements must be reconciled, and the commitment to backfilling and sealing must be maintained.

Response
DOE has modified the text in Section 4.1 of the Final EIS to be consistent with the text in Section 2.1.2.4 (formerly Section 2.1.2.3) with regard to backfilling and sealing.

7.1.1 (5588)
Comment - EIS001887 / 0213
Page 4-6; Section 4.1.1.2 - Impacts to Land Use and Ownership from Construction, Operation and Monitoring, and Closure

This section precludes backfill of the emplacement drifts. This is inconsistent with the design features and alternatives that are being held open to bound the impacts of the different thermal load alternatives and is inconsistent with the current design approach.

Response
The current design, described in the Supplement to the Draft EIS and carried forward to the Final EIS, and the design described in the Draft EIS do not include backfilling of the emplacement drifts.

DOE based the statement in Section 4.1.1.2 of the Draft EIS—that it would exclude the emplacement drifts from backfilling—on the Viability Assessment (DIRS 101779-DOE 1998). The current design assumes that the emplacement drifts would not contain backfill; the Supplement describes the consequences of this design.

7.1.1 (5624)
Comment - EIS001887 / 0249
Page 4-72; Section 4.1.11.2 - Impacts to Utilities, Energy, Materials, and Site Services from Construction, Operation and Monitoring, and Closure

Construction Material: The Draft EIS fails to evaluate the impact on titanium resources from the planned use of titanium drip shields in 100 miles or more of emplacement tunnels. The current repository design calls for the use of such drip shields as an integral part of the waste isolation system. The Draft EIS, however, addresses only the use of concrete, steel, and copper as the primary construction materials. The impact of extraordinarily large amounts of titanium for waste package protection should be addressed.

Response
As described in Section 4.1.15 of the Final EIS, the annual requirement for titanium for drip shields ranges from about 4,300 to 6,500 metric tons, depending on the operating mode and packaging scenario. The magnitude of the comparison is the result of low U.S. production of the basic raw material, because the United States imports most of the titanium raw material. Although the annual U.S. production of titanium raw material is only 21,600 metric tons, the annual U.S. capacity to produce titanium ingots is 78,200 metric tons (DIRS 152457-Gambogi 1997). The maximum annual program need is a little more than 8 percent of the current annual U.S. ingot production. Titanium is classified as a Federal Strategic and Critical Inventory material and is the ninth most common element in the Earth's crust (DIRS 107031-U.S. Bureau of Mines 1995). Because the drip shields would not be needed until repository closure, there would be adequate time (more than 100 years) to expand production of titanium raw material or to import additional raw material in advance of the need to reduce impact on markets.

7.1.1 (5630)
Comment - EIS001887 / 0257
Page 4-99; Section 4.2.1.1 - Retrieval Activities

The figure on this page gives inadequate detail as to the exact location of the proposed waste retrieval and storage area, even when combined with Figure 3-12. The figure on this page should give more detail as to the exact location of the storage area.

Response
One of the alternative sites for the Retrieval Facility is in Midway Valley near the repository site. DOE has not yet determined the design of this facility or its exact location. However, the Department believes that the information in the EIS is adequate for estimating the representative environmental impacts from using this site for waste retrieval.

7.1.1 (5665)
Comment - EIS001887 / 0284
Page 5-28; Section 5.4.1 - Consequences from the Groundwater Exposure Pathway for the High Thermal Load Scenario

The discussion of the waste package lifetime should be rewritten to indicate the new configuration of the waste package, i.e., the Alloy-22 on the outside.

Response
Since publication of the Draft EIS, the waste package design has evolved into a more robust and corrosion resistant design with an outside layer of Alloy-22. The appropriate sections of the Final EIS (including Section 5.2.2) now reflect this updated design.

7.1.1 (5673)
Comment - EIS001887 / 0292
Page 5-39; Section 5.6 - Consequences from Chemically Toxic Materials

Would there be any changes to the discussion in this section based on the change in the waste package design? If so, the Draft EIS should indicate these changes.

Response
Because of the evolving nature of the design of the repository, DOE issued a Supplement to the Draft EIS in May 2001 for public review. As indicated in the Supplement, the waste package has been re-designed. This new waste package design information was carried forward to the Final EIS. The conclusions reached in Section 5.6 with regard to chemically toxic materials are still valid for the new design.

7.1.1 (5720)
Comment - 010073 / 0009
Page 1-2 - The SDEIS does not consider the potential for Yucca Mountain to accommodate spent fuel in amounts beyond that considered within the DEIS due to the closer spacing to be achieved through the flexible design. The SDEIS should provide a new estimate of the total potential spent fuel and other high-level radioactive waste that could be emplaced in Yucca Mountain.

Response
Under the NWPA, the repository would be limited to 70,000 metric tons of heavy metal (MTHM); therefore, the EIS evaluates the flexible design scenarios that support 70,000 MTHM. Based on public comments during EIS scoping hearings, the EIS also evaluates the impacts of emplacing more than 70,000 MTHM in a repository (Inventory Modules 1 and 2) (see EIS Sections 8.2 and 8.3.2 for a discussion of the inventories considered and the associated impacts). These inventory projections have not changed since the Draft EIS was published, but the impacts have been updated to reflect the flexible design. The EIS does not evaluate inventories greater than those of Modules 1 and 2.

7.1.1 (5948)
Comment - EIS001622 / 0052
The Department could not find any detailed description of the repository closure including the sealing of shafts and ramps, etc. This element of the project should also be discussed in more detail.

Response
Supporting documents to the EIS such as the *Monitored Geologic Repository Project Description Document* (DIRS 151853-CRWMS M&O 2000), and other referenced supporting documents, discuss such issues as shaft seal design. It has been established that the current technology for shaft sealing will provide for sufficient integrity of these sealed openings that they will behave as well as the host rock in long-term performance. The EIS relies on all of these supporting documents, including the Science and Engineering Report, to provide discussions of such supporting details.

7.1.1 (6417)
Comment - EIS001632 / 0007
Page 2-17, Figure 2-10 does not identify the proposed locations for the cask maintenance facility and landfill. Locations of these need to be identified in order to assess their potential impacts.

Response
DOE has considered onsite and offsite locations for the Cask Maintenance Facility. A site for the landfill has not yet been identified. DOE would identify an appropriately sized landfill at the repository site for nonhazardous and nonradiological construction and sanitary solid waste, and for similar waste generated during operation, monitoring, and closure of the repository. Although the Cask Maintenance Facility may not be located at the Yucca Mountain site (therefore not depicted on current site drawings), the EIS analysis assumed the landfill and the Cask Maintenance Facility would be located at the repository. By doing so, the environmental impacts of these facilities were considered in the EIS. DOE believes that the amount of information in the EIS on these facilities is adequate to determine representative environmental impacts.

7.1.1 (6418)
Comment - EIS001632 / 0008
Page 2-21, 2.1.2.1.5: The second paragraph mentions "water used for cooling tower operations." We found no other description or reference to a cooling tower. The final EIS should explain the purpose of this operation and any possible radiological or chemical contamination from the cooling tower.

Response
Figure 2-10 shows the location of the cooling tower at the North Portal Operations Area. DOE would use the cooling tower exclusively for air conditioning of surface facilities at the repository. The tower would not be a source of chemical contamination or radiological emissions. The Final EIS has been revised to state that the cooling tower is not a source of chemical or radiological emissions or contamination.

7.1.1 (6996)
Comment - EIS000817 / 0006
Once underground, you expect these casks to be retrievable. You think you can return the waste to the surface. How? Who will do it? How hot will the tunnels be? 400° or more? What if the remote equipment breaks down, a tunnel caves in, or there is an earthquake? What if the cask welds or seals go before you expected them to? These are the "achilles heels" of these casks. The weaknesses in fabrication will cause problems. How are you going to unload all those transport or storage casks at Yucca Mountain? How are you going to repackage all that spent fuel and HLW at Yucca Mountain before you even consider putting it underground? What condition will that fuel really be in after storage, transport, storage, transport? How many times? What happens to fuel in the wet-to-dry process repeatedly? It is wet in the reactor and pool, dry in casks at the plant, wet in unloading again, dry in transport, wet in unloading again? Dry in interim storage, wet or dry transfer to a disposal cask? Dry in the mountain at first, and wet again at the end? Think of a rock in a stream encrusted with moss, etc. Take it out, dry it in the sun--what happens? Stuff gets hard and brittle and falls off--especially if you transport the dry rock in your pocket (like fuel in a cask). Then what happens if you put the rock in water again--say water full of chemicals like a reactor pool? Stuff reacts--falls off--forms gases--not steam what? Remember spent fuel has pinhole leaks and hairline cracks in cladding--any amount is acceptable to NRC [the Nuclear Regulatory Commission]. And rods may be depressurized. Crud falls off. Blisters fall off and expose holes. Then what?

Response
The flexible design described in the Supplement to the Draft EIS and the Final EIS includes the ability to operate the repository in a range of operating modes that address higher and lower temperatures and associated humidity conditions. Higher-temperature means that at least a portion of the emplacement drift rock wall would have a maximum temperature above the boiling point of water at the elevation of the repository [96ºC (205ºF)]. The lower-temperature operating mode ranges include conditions under which the drift rock wall temperatures would be below the boiling point of water, and conditions under which the waste package surface temperature would not exceed 85ºC (185ºF). To bound the impact analysis, DOE considered conditions under which the rock wall temperatures would be above the boiling point of water, and conditions under which waste package surface temperatures would not exceed 85ºC.

The design of the subsurface facilities includes equipment and facilities for retrieving waste packages prior to closure of the repository. It is true that humans would not be able to enter an emplacement drift once it has been loaded with waste packages without the use of thermal and radiation shielding. Human entry is not planned should retrieval be required. However, provisions have been considered for recovering from accidents or malfunctions. See, for example, the *Yucca Mountain Science and Engineering Report* (DIRS 153849-DOE 2001).

Even though DOE would not expect to retrieve the waste, the impacts of such an action are examined in Section 4.2 of the EIS. Based on the current design, DOE would use the same equipment for retrieval that would be used for emplacement. Therefore, the Department would gain experience in operating and maintaining the equipment should retrieval of the waste become necessary. Design of the repository includes equipment that would be appropriate for the high temperatures and radiation fields in the emplacement drifts. The design criteria include effects from natural phenomena that could result in cave-in or other problems. In addition, Section 122 of the NWPA and the Nuclear Regulatory Commission require the repository to maintain the ability to retrieve emplaced waste for at least 50 years after the start of emplacement.

Design of the subsurface facility is still evolving. DOE would ensure that facilities and equipment meet all design requirements and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design of the retrieval equipment before licensing the repository.

The commenter is correct in asserting that the surface facilities would receive a variety of casks certified by the Nuclear Regulatory Commission. The design of the facilities upon which DOE based the analyses in the EIS includes appropriate facilities to handle transportation casks containing disposable canisters, dual-purpose canisters, or bare fuel assemblies. Section 2.1.2.1 of the EIS describes these facilities. Although several spent nuclear fuel storage technologies are in use at various commercial and DOE sites, DOE would ship spent nuclear fuel to the repository in disposable canisters in a transportation cask, dual-purpose canisters in a transportation cask, or as individual assemblies in transportation casks. Design of the Waste Handling building would accommodate the unloading of all three types of canisters. As for loading the various types of fuel and canisters into disposal containers, there are 10 designs for disposal containers to provide all the repacking options needed. Five of the designs would be for spent nuclear fuel from commercial nuclear plants and five would be for DOE spent nuclear fuel.

The conditions to which spent nuclear fuel is subjected after removal from the reactor to the time when it would be emplaced in the repository are much less severe than the conditions under which the fuel operates in service. Therefore, degradation of the fuel would be unlikely during the transition from in-service to disposal. A small amount of radioactive crud could be dislodged during handling but DOE has designed all of the facilities to deal routinely with the resulting contamination. In addition, DOE has incorporated into the design a system to deal with the small number (less than 1 percent) of damaged fuel assemblies. The operating experience in handling spent nuclear fuel at commercial nuclear plants is substantial, and DOE has used this experience to ensure that the facilities supporting Yucca Mountain would work as designed.

7.1.1 (7045)
Comment - EIS001337 / 0008
In DEIS scoping comments, the County [Lincoln] and City [Caliente] noted that the disposal of radioactive waste in a deep geologic repository at Yucca Mountain is characterized by both real and perceived risk. The risk of exposure to radiation from atmospheric pathways was noted an important issue to residents of Lincoln County. Volcanism and criticality control were presented as two issues which the County believes every aspect of repository development and operation must be evaluated against. The County and City recommended that the DEIS include a comparative evaluation of the extent to which alternatives for accomplishing construction, emplacement, closure, and post-closure phases of the facility achieve containment of radioisotopes during volcanic eruption and loss of criticality control. The DEIS does not provide a comparative evaluation of the extent to which alternatives for construction, emplacement, closure and post-closure achieve containment of radioisotopes during volcanic eruption or loss of criticality control. The FEIS should include such a comparative evaluation.

Response
DOE has evaluated the long-term geologic stability of Yucca Mountain, including the potential for volcanoes. Volcanic activity has been waning in the recent geologic past; the probability of a volcano that could disturb the repository is very low (see Section 3.1.3.1 of the EIS). Sections 5.7.2 and 5.8 of the EIS summarize potential impacts to repository performance from volcanic disturbances and from criticalities, respectively. DOE analyzed the effects of both a volcanic eruption, which could release volcanic ash and entrained wastes into the atmosphere, and the intrusion of magma into the emplacement drifts, which could damage waste packages and contaminate the underlying aquifer. DOE estimated potential impacts on the nearest population to the south, conservatively assuming wind in that direction, and determined that the resulting radiation dose would be small. DOE believes that it is not reasonable to rank one concept for a repository ahead of another in terms of their resistance to the effects of volcanism or criticality because such events would be very unlikely.

7.1.1 (7173)
Comment - EIS001337 / 0064
Page 1-17 3rd paragraph. It is not clear in reviewing the DEIS whether DOE has made a finding as to whether the repository is capable of accommodating all of the various waste volumes potentially needing disposal at the Yucca Mountain site. Can the Yucca Mountain site handle all of the waste described in this paragraph?

Response
The EIS describes the environmental impacts from the disposal of up to 70,000 metric tons of heavy metal of spent nuclear fuel and high-level radioactive waste. The NWPA restricts the first repository to 70,000 metric tons of heavy metal. DOE has determined that there is sufficient space within Yucca Mountain for this amount of waste. Chapter 8 describes the cumulative impacts from the Proposed Action along with additional amounts and types of waste that could be disposed of in the repository, providing that Congress authorized such an action. DOE has determined that there is sufficient space within Yucca Mountain for this additional waste.

7.1.1 (7297)
Comment - EIS001832 / 0031
DOE should increase the size of the early receipt facility in case lag storage needs increase due to delays or to accommodate future evolutions in repository and waste package design.

The DEIS considers the possibility of early receipt of spent fuel at the proposed Yucca Mountain repository. The early receipt facility would be capable of storing as much as 10,000 MTU of spent nuclear fuel and high-level radioactive waste in concrete storage modules. Possible changes under consideration for the repository and waste package design may result in the need for lower heat-load waste packages being emplaced in the repository. DOE should consider including an analysis of the impacts associated with a larger capacity early receipt facility in order to provide adding cooling of spent fuel to meet the needs of possible repository design evolutions.

Response
The flexible design presented in the Supplement to the Draft EIS includes provisions for surface aging of up to 40,000 metric tons of heavy metal to support the low-operating temperature operating mode of the repository. DOE believes the impact analyses of the high- and low-temperature operating modes presented in the Supplement to the Draft EIS (Chapter 3) and the Final EIS (Chapter 4) adequately reflect the range of possible impacts.

7.1.1 (7425)
Comment - EIS001912 / 0017
If the subsurface design and performance is uncertain which leads to uncertainties about surface facility design scenarios, how can DOE select among one of its packaging scenarios?

Response
DOE presented a range of packaging scenarios in the Draft EIS to define the range of consequences associated with the Proposed Action. The surface and subsurface systems described in the Draft EIS and in the Supplement to the Draft EIS, and carried forward to the Final EIS, are not tightly coupled; the only interface between the surface and subsurface systems is the transporter that takes sealed waste packages from the waste handling building to the emplacement drifts. A significant change in either the surface or subsurface system would not necessarily lead to substantial changes in the other system.

7.1.1 (7463)
Comment - EIS000817 / 0009
The waste handling facility at Yucca will be receiving a huge jumble of so-called "generic" cask designs -- mostly new, just NRC [Nuclear Regulatory Commission]-certified -- (not time tested or ever even built for prototype testing before use at reactors). Dry cask storage is still in its infancy. But NRC keeps certifying cask after cask and utilities change the designs for the facility needs -- meaning they all end up really being site-specific designs. All the spent fuel will be in different containers, having different past histories by the time they get to Yucca handling. How on earth can you have one facility appropriate to unload all of these different designs and assemblies? The specifics here are not being looked at and they need to be evaluated -- in detail! How are you going to unload and repackage all these casks? What are costs and doses here? We need to know this first before any repository is ever considered.

Response
The commenter is correct in that the repository would receive a variety of casks that have been certified by the Nuclear Regulatory Commission. The design of the surface facilities at the repository, upon which DOE based the analyses in the EIS, includes facilities to handle transportation casks containing disposable canisters, dual-purpose canisters, and bare fuel assemblies. Section 2.1.2.1 of the EIS describes these facilities. Even though there are several spent nuclear fuel storage technologies licensed and in use at commercial and DOE sites, the Department would ship all spent nuclear fuel to the repository in disposable canisters in a transportation cask, dual-purpose canisters in a transportation cask, or as individual assemblies in transportation casks. Design of the Waste Handling building would accommodate the unloading of all three canister types. As for loading the various types of fuel and canisters into disposal containers, the repository design now includes 10 specific designs for disposal containers to provide all repacking options needed. Five of the designs would be for spent nuclear fuel from commercial nuclear plants and five would be for DOE spent nuclear fuel.

Design of the surface facilities is evolving. DOE would ensure that these facilities and equipment at the repository would meet all design requirements and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

With regard to the costs for unloading casks at the surface facilities and radiation exposure, Chapter 4 of the EIS includes detailed impact analyses (including costs and exposure to workers and the public) of unloading operations.

7.1.1 (7471)
Comment - EIS000817 / 0012
Problem after problem after problem. So don't expect a person like me, well versed in the real history of dry cask storage, to blithely accept your plan to unload and load casks at Yucca Mountain in a handling facility. There will be more unexpected problems there. And don't expect me to believe retrieval is as easy as you make it sound on paper -- without the detailed analysis necessary for this EIS. You have got to look at the track record of dry cask storage so far, and evaluate what the utilities are doing now and how the casks they use and what they are allowing will affect handling at the repository in the future. It all starts with spent fuel behavior in casks at reactors. That affects your system and has got to get more attention. It is part of your concern.

Response
DOE would not use dry storage casks like those at commercial and DOE sites for disposal at the repository. Spent nuclear fuel at the 77 commercial and DOE sites would be transported to the repository in casks licensed according to 10 CFR Part 71. For disposal, the spent nuclear fuel would be removed from the transportation casks and loaded into disposal containers. There exist systems that are dual-purpose and multi-purpose, with components that meet the rigorous requirements for storage and transport, or storage, transport, and disposal. Section 2.1.1.1 of the EIS discusses the various packaging scenarios. As described in Section 4.2 of the EIS, the design of the repository includes equipment and facilities for retrieving the waste, even though retrieval is not part of the Proposed Action.

DOE would ensure that the design of surface facilities and equipment would meet all requirements and peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

7.1.1 (7814)
Comment - EIS001653 / 0015
Is the surface facility design dependent upon transportation activities? If so please explain the relationship, which exists between the surface design scenarios and the selected transportation scenarios.

Response
The transportation and subsurface emplacement scenarios would influence the design of the surface facilities at the repository. Changes in the design of cask, containers, and waste packages, and the schedule for the receipt and emplacement of waste, would affect the design of the surface facility. For example, if most of the waste shipments arrived in permanently sealed multi-purpose canisters (canisters designed for shipment, surface storage, and emplacement in the repository), DOE could put the canisters directly in disposal containers. If most spent nuclear fuel assemblies arrived in shipping casks or in dual-purpose canisters, DOE would configure the surface facilities and equipment with a greater capacity to remove individual assemblies from the casks or canisters and stage them before packaging them individually in disposal containers. The surface facilities would not be very dependent on transportation routes.

7.1.1 (7982)
Comment - EIS000817 / 0045
On p. 2-16 you realize everything also depends on how the waste arriving is packaged. You blithely say you will test interior gases of these casks, vent and cool them, and remove their lids as if it is just a common practice. Well, it has never been done with any of the present cask designs up for certification holding 21-24 etc. assemblies. You don't know how this will work at all. Especially with the lack of standardization and integration of the many cask designs utilities are loading -- with any total waste system DOE has in mind. Your p. 2-19 is a fantasy at this point. And so is p. 2-20 -- so you have a pool to empty the dual purpose canisters -- every design? How? What chemicals in the pool? How [are] gases released? How [are] filters cleaned? What reactions [are] possible with cask materials and pool water? The casks affect the pool and the pool affects the casks -- and over time how dirty will that pool become? Can you really do this?

Response
The assertion that testing and venting of interior gases from waste casks has never been done is inaccurate. The spent nuclear fuel at the 77 commercial and DOE sites would be transported to the repository in casks licensed according to 10 CFR Part 71. DOE has more than twenty years of experience using these transportation casks, including initial cask-unloading operations that check the cask for contamination, sample interior gases, vent the interior gases through filtration, and unbolt the lid. All transportation casks used to ship spent nuclear fuel would comply with 10 CFR Part 71 and include features to accomplish these initial cask-unloading operations.

DOE has extensive experience with pools for spent-fuel loading and unloading operations. The design of the spent nuclear fuel pools to be used for unloading in the Waste Handling Building is similar to the design of pools used at DOE and commercial facilities. The design includes systems to continually treat the pool water for removal of radioactive contamination by pumping the pool water through particulate filtration, ion exchange, and sterilization systems. Vacuum systems and leak-detection systems are also included.

7.1.1 (7986)
Comment - EIS000817 / 0047
You talk about maintaining pressure differentials to ensure an air flow for ventilation. Depending on anything not passive is risky. Fans can break. Then what? How contaminated would a fan be? How long to replace a defective one or broken one with the standby one? If that one has problems, how long before you have a problem heat up in the repository? What are risks here?

Response
Ventilation will be active to help remove heat from the emplacement shafts during the preclosure period. In the event of a ventilation failure, a very slow build up of heat would begin in the repository. There would be no adverse consequences from this heat. For example, other repository designs were evaluated without active ventilation and repository performance was acceptable. The forced-air ventilation system has been added as a conservative defense-in-depth feature to maintain a lower drift-wall temperature (described in the Supplement to the Draft EIS that was released for public review in May 2001 and the Final EIS). If a fan failed, it could be repaired or replaced within a couple of weeks; this would not cause any detectable impacts.

The exhaust system is designed to prohibit the exhaust of radioactively contaminated air. Design of the repository ventilation system includes air monitoring for radioactivity and a feature to avert exhaust through high-efficiency particulate air filtration prior to exhausting if any radioactivity is detected.

The design of the repository ventilation system is still evolving. DOE would ensure that the final design meets all requirements (including development of adequate maintenance and inspection programs) and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

7.1.1 (7988)
Comment - EIS000817 / 0048
P. 21 -- What is the “cooling tower”? You say water from it will be put in ponds lined with “heavy plastic sheets”? How long will these last? And how contaminated will that area become long term? -- Can wastewater leak at seams of sheets? No plastic sheet lasts very long.

Response
The design of the repository includes cooling towers adjacent to the utility building to support heat rejection from the utility building chiller systems. Water from the cooling tower, among other industrial streams from the water-softening and deionized water systems would be collected in an evaporation pond located in the North Portal Operations Area. The purpose of this pond would simply be to collect and evaporate the collected wastewater. Water from these industrial streams would not contain any hazardous materials.

The design of the repository is still evolving. DOE would ensure that the industrial wastewater-evaporation system meets all applicable design requirements (including development of adequate maintenance and inspection programs) and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

7.1.1 (8001)
Comment - EIS000817 / 0056
I am very interested in the support for the casks. Why are they designed this way? I gather the cask sits horizontally on a "V" of steel. What kind of steel? This is a crucial area of metal on metal and needs as much corrosion resistance as possible, for water could collect or condense there later on and rust these two metal surfaces together and prevent retrieval. This is a real concern. It was with [the] VSC-24 canister sitting on [the] metal liner of the concrete outer shell. NRC [Nuclear Regulatory Commission] demanded a different design and ceramic tiles were the accepted solution between these metal-to-metal surfaces so they wouldn't corrode together and prevent retrieval there. But -- handling procedures had to be very carefully directed not to set the inner canister down too hard on the tiles and crack them. Are they now cracked in loaded VSC-24s? Nobody knows. None has ever been unloaded. What is DOE's evaluation of corrosion rusting the support and the cask together over time? Has this been done? It needs to be done.

Response
The waste package support evaluated in the Draft EIS was a steel "V" type; it would be made of the same material that would be used to fabricate the waste package. The design of both the waste package and support were updated in the Supplement to the Draft EIS that was issued for public review in May 2001. The updated design would place the waste package on an emplacement pallet during the transfer of the package to the subsurface. Both the outer barrier of the waste package and pallet would be made of Alloy-22. If waste retrieval were required, the waste package and pallet would remain together and transferred to the surface.

The design of the subsurface facility is still evolving. DOE would ensure that the design of these facilities and equipment meet all requirements and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

7.1.1 (8003)
Comment - EIS000817 / 0058
If you reuse the railcar and the shielded transporter, how contaminated will they be over time? How will that affect the outer surface of waste packages -- and eventual doses at retrieval? P. 2-32 sounds like playing with a train set -- and you expect this all really to work as expected over all that time? I sure don't. What are doses if somebody has to get in there and fix that gantry or locomotive system? You know it's like these outer space landers -- one little screw or something loose and the whole thing goes "Kaflooey." All that money lost! I predict problem after problem with your system that will cost the public plenty. There is too much that can go wrong here.

Response
The current design of the repository specifies that loaded waste packages are remotely decontaminated to specified activity levels prior to loading into the waste package transporters. A waste package would also be welded shut, inspected, and leak tested to ensure no leakage of radioactive contamination. Thus, contamination of the rail car and transporter would be minimized such that dose rates resulting from such incidental contamination would be negligible and would have no discernible effect on the dose rates from the spent nuclear fuel in the waste package.

The design of the subsurface facility is still evolving. DOE would ensure that the facility and equipment designs (including necessary radiological surveys and decontamination of the transporter) meet all design requirements and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

7.1.1 (8018)
Comment - EIS000817 / 0069
P. 2-57 -- You need drip shields -- but will they work? How have they been tested? What ceramic coating has been tested? If rockfall could crack it, it may exacerbate corrosion in the cracks; have you thought of that? Water will collect in cracks in ceramic and rust there. What "additions" and "fillers"? What "getters" under waste packages? Anything -- any other materials -- chemicals especially -- need to be evaluated for final repository conditions when everything in there becomes mushed together in a "radioactive soup." -- What will be the interactions of materials then? And interactions of new materials formed from interactions? This is crucial to your plan and must be evaluated in detail.

Response
As described in the Supplement to the Draft EIS (released for public review in May 2001) and in the Final EIS, titanium drip shield would be installed over each waste package just prior to repository closure. The drip shields would be an additional barrier to corrosion by diverting any water away from the waste packages. The drip shields would survive rockfalls.

Since DOE issued the Draft EIS, the design of the waste package has evolved for the reasons mentioned in the comment (cracks in ceramic coatings). Therefore, the design no longer has these coatings. The waste package design now consists of a highly corrosion-resistant outer barrier of Alloy-22 with an inner structural liner of stainless steel.

The design of the repository is still evolving. DOE would ensure that the final design of facilities and equipment (including compatibility of all subsurface materials, including fuel and engineered and natural barriers) would meet all requirements and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

"Getters" and "fillers" are yet-to-be-identified materials that could be added beneath and inside the waste package to further retard the migration of radionuclides. If DOE decided to include such features in the repository design, it would have to evaluate them fully to determine their impacts on the drift environment. At present, these features are not part of the design of the repository.

7.1.1 (8312)
Comment - EIS000817 / 0110
Figure 4-6. Where did this "typical" concrete storage module design come from? I've never seen one like it. How can there be an air inlet and an air outlet at the top of the cask? All the casks I know have inlets at the bottom and outlets at the top, and NRC [Nuclear Regulatory Commission] has stated that if all inlets on the bottom are blocked, the outlets at the top will not act as inlets. Please explain your design. What are the locking plates for? Is this a 2-piece thing, or what? If so, why? You have only a shield lid on top -- isn't a double welded closure demanded by NRC? Also, I don't understand the steel liner -- why isn't it under the waste package too? And if there is metal-to-metal contact at the base of the waste package and the liner, you need to prevent corrosion there with ceramic tiles or something. Moisture can condense on the flat surface of the bottom of the waste package.

Response
Conceptual, rather than typical, could be a more appropriate title for Figure 4-6. The figure is based on preliminary design work for the Multi-Purpose Cask System (see DIRS 101775-DOE 1994); this system is not currently licensed or in use. The conceptual design was used to estimate such things as crane capacities, pad sizes, and material quantities, but should not be used for evaluating detailed features such as cask ventilation. The final design would have to be approved by the Nuclear Regulatory Commission prior to use if retrieval was necessary.

The locking plates shown in Figure 4-6 simply provide the means to assemble a multi-piece unit, which can be more economically shipped and handled at the repository. From the figure it can be seen that at the locking plate location, the thick steel components of the locking plates provide shielding equivalent to the concrete cross-section.

The steel liner in the typical unit is simply a heat barrier for the concrete wall and as depicted in Figure 4-6; the bottom of the waste package is not exposed to concrete.

The shield lid of the storage unit provides no sealing to the spent nuclear fuel. The double seal required for storage by 10 CFR Part 72 is accomplished by the waste package itself, which becomes part of the storage system when it is placed in the typical storage unit.

The design of the repository is still evolving. DOE would ensure that the design of the facility would meet all requirements and receive necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

7.1.1 (8567)
Comment - EIS000817 / 0175
P. 9-15 Access to Waste Packages -- All these fillers, etc. -- how would you get this all out to get at the cask? "Modified waste emplacement" -- this sounds more feasible -- a main tunnel for access and casks in alcoves or short side tunnels -- The idea of a track getting clogged by a rock fall or something, and not usable, would certainly be easier to "unclog" if casks weren't in the way. Keep the main tunnel for personnel movement and use alcoves for waste -- easier to monitor and repair and replace. Also less chance of one problem causing a mess with the whole tunnel. This paragraph is full of some good creative thinking here. Work out all possibilities and test them. Take your time. Do this the best way possible if you are going to do it at all. Keep your mind free to all possibilities. Maybe nobody has thought of the best way to do this yet. Keep some people just at the job of brainstorming or have brainstorming sessions for personnel together periodically. The best document I've read is when NWTRB [the Nuclear Waste Technical Review Board] had that creative meeting on waste package ideas. It was great! I read the transcript. People interacting who are experts -- saying what comes to mind as workable and then discarding it, but at least not "bogged down" in one old idea that won't work.

Response
DOE has considered alternate configurations for the main tunnels and emplacement drifts at several stages during the design of the repository. DOE considers the current design, which incorporates parallel emplacement drifts connected to main drifts, to be the most appropriate arrangement for construction, handling, and operation.

7.1.1 (8568)
Comment - EIS000817 / 0176
P. 7-16 Rod Consolidation -- I've read a lot about this in the past and it "sounds" good, but the end fittings create a problem. I guess it costs more and the utilities won't do it anyway. It would save space. But no cask designs are out there for this that I know. They were interested in this years ago and discarded the idea.

Response
Section E.2.2.6 of the EIS considered rod consolidation in conjunction with a wide range of design options and alternatives. Rod consolidation is not included in the current design for the Yucca Mountain repository.

7.1.1 (8570)
Comment - EIS000817 / 0178
P. 9-16. 2-level repository -- would help retrieval, but could one above the other allow for more avenues of seepage eventually?

Response
As this comment suggests, a multilevel design could provide a quicker pathway for seepage to reach certain waste packages. However, the updated flexible design evaluated in the Final EIS does not include a consideration for waste packages being emplaced in multiple layers.

7.1.1 (8580)
Comment - EIS000817 / 0184
P. H-5. 4 PWR assemblies in a basket? I had no idea that's all you planned to put in there. A suspended basket should not be allowed to go above another basket -- redesign this. NRC [the Nuclear Regulatory Commission] doesn't allow a cask of fuel to be carried over other assemblies in the pool -- and for good reason.

Response
The baskets used for transferring assemblies of spent nuclear fuel are designed to hold four pressurized-water reactor assemblies or eight boiling-water reactor assemblies. During all basket transfers, the operations would be conducted to avoid moving one basket over another. However, in that part of the operation where the basket would be placed in the assembly drying station, the assemblies would be close enough together so that it would not be possible to ensure that a failure that caused the suspended basket to drop would not result in the dropped basket contacting another basket. If a release of radionuclides occurred as a result of the basket drop, a corresponding coincident failure (within 24 hours) of the high-efficiency particulate air filtration system would be required before workers or the public could be exposed to any significant radioactivity. For the design described in the Supplement

to the Draft EIS and the Final EIS, coincident failures of the basket transfer system and the high-efficiency particulate air filtration system are not considered to be credible.

7.1.1 (10453)
Comment - EIS001337 / 0013
The County [Lincoln] and City [Caliente] recommended that the DEIS assess alternative materials which might be used to achieve closure for their relative contribution to risk management, retrievability and cost. The DEIS does not appear to consider the risk management, retrievability and cost attributes of alternative materials which might be used to achieve repository closure. Absent such information, closure decisions cannot be supported by the document.

Response
As a result of the evaluation of the "Viability Assessment of a Repository at Yucca Mountain" (DIRS 101779-DOE 1998) and concerns such as those of the Total System Performance Assessment Review Panel, DOE modified the waste package design and added a drip shield over the waste packages. The waste package would have Alloy-22 as the outside layer with stainless steel on the inside. The titanium drip shield would add further defense-in-depth to the design.

Because of these evolving design changes, DOE issued a Supplement to the Draft EIS in May 2001. The information provided in the Supplement, and incorporated into the Final EIS, describes the potential impacts associated with the design modifications, which took into consideration thermal, mechanical, and chemical performance, ease of fabrication, costs, and compatibility with other materials.

While DOE believes the design enhancements will improve the proposed repository's chances of complying with regulatory requirements over the long term, it would maintain flexibility with regard to when it would ultimately close the repository and under what conditions it would retrieve the waste material. To maintain flexibility and an ability to respond to changing conditions and technologies, Section 122 of the NWPA requires retrievability at a high-level radioactive waste repository. Federal regulations (10 CFR Part 63) require that the repository be designed to preserve the option of waste retrieval on a reasonable schedule for as long as 50 years after the start of waste emplacement. Consistent with these requirements, the operational plan for the Yucca Mountain Repository provides for a design and management approach that isolates wastes from the public in the future while allowing flexibility to preserve options for modifying emplacement and retrieving waste. This design would maintain the ability to retrieve emplaced materials for at least 100 years and possibly as long as 300 years in the event of a decision to retrieve the waste, either to protect the public health and safety or the environment, or to recover resources from spent nuclear fuel. During this period, the repository would remain accessible for scientists to continue testing and monitoring while providing more flexibility for future generations of scientists and engineers to determine the timing and methods of repository closure.

Once the repository is closed, a postclosure monitoring program would be implemented pursuant to 10 CFR Part 63. This program would include monitoring activities around the repository after the facility had been closed and sealed. The program would include continued oversight to prevent barriers of increasing the radiation beyond allowable limits. The details of this program would be defined during the processing of the license amendments for permanent closure.

7.1.1 (11436)
Comment - EIS001888 / 0355
[Clark County summary of comments it has received from the public.]

Commenters requested that the EIS justify the selection of the alternatives, and that the alternatives and options be sufficiently defined to comprehensively describe the affected environment, and to allow an equivalent analysis (between alternatives) of potential positive and negative impacts to human health and the environment (e.g., groundwater, air, socioeconomics) from routine operations and accidents during construction, operation, and closure. The types of detail identified include: construction methods, facilities, used at Yucca Mountain, subsurface attributes [to] ensure that SNF and HLW can be contained, surface and subsurface operations (e.g., handling, packaging, emplacement, secondary waste handling, mitigations), anticipated waste package characteristics (e.g., fuel age, heat, size), retrieval scenarios.

Response
The Proposed Action is to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain. The only alternative to the Proposed Action considered in the EIS is the No-Action Alternative. Under the Proposed Action, DOE examined several transportation modes and routes and various design alternatives. Many aspects of the design and operation of the repository are based on conservative assumptions or covered by a range of possibilities. This approach allows DOE to continue to refine and improve the design before settling on final design and operational specifics. DOE believes that the level of detail presented in the EIS is sufficient to analyze and compare the various alternatives and design options. During any licensing process with the Nuclear Regulatory Commission, DOE would evaluate the design alternatives and options in greater detail, as necessary, to demonstrate compliance with applicable requirements.

7.1.1 (11437)
Comment - EIS001888 / 0514
[Clark County summary of comments it has received from the public.]

Commenters requested that the EIS justify the selection of the alternatives, and that the alternatives and options be sufficiently defined to comprehensively describe the affected environment, and to allow an equivalent analysis (between alternatives) of potential positive and negative impacts to human health and the environment (e.g., groundwater, air, socioeconomics) from routine operations and accidents during construction, operation, and closure. The types of detail identified include: pre- and post-closure monitoring programs, and institutional controls.

Response
The Proposed Action is to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain. The only alternative to the Proposed Action considered in the EIS is the No-Action Alternative. Under the Proposed Action, DOE has defined several transportation modes and routes and various design alternatives. Many aspects of the design and operation of the repository are based on conservative assumptions or covered by a range of possibilities. This approach allows DOE to continue to refine and improve the design before settling on final design and operational specifics. DOE believes that the level of detail presented in the EIS is sufficient to analyze and compare the various alternatives and design options. During any licensing process with the Nuclear Regulatory Commission, DOE would evaluate the design alternatives and options in greater detail, as necessary, to demonstrate compliance with applicable requirements. DOE expects that the environmental consequences of the final design would be adequately bounded by the consequences of the design analyzed in the EIS.

As described in Section 4.1 of the EIS, DOE would conduct testing and performance confirmation activities during all the phases of the repository project prior to closure to evaluate the adequacy of the information it used to demonstrate compliance with the performance objectives.

DOE would also design and implement a postclosure monitoring program in compliance with the Nuclear Regulatory Commission regulations (at 10 CFR Part 63). Prior to closure, DOE would submit a license amendment to the Commission for review and approval. The license amendment application would include among several items, an update of the assessment of the performance of the repository for the period after closure; a description of the postclosure monitoring program; a detailed description of the measures to be employed to regulate or prevent activities that could impair the long-term isolation of the waste; and methods to preserve relevant information for use by future generations.

The application also would describe DOE's proposal for continued oversight to prevent any activity at the site that would pose an unreasonable risk of breaching the repository's engineered barriers, or increase the exposure of individual members of the public to radiation beyond allowable limits. DOE has modified the EIS to include the types of monitoring and other institutional controls that would be contemplated. The details of this program, however, would be defined during the processing of the license amendment for closure. This would allow DOE to take advantage of new technological information, as appropriate.

As described in Section 2.1 of the EIS, the Proposed Action would use two types of institutional controls—active and passive. Active institutional controls (monitored and enforced limitations on site access; inspection and maintenance of waste packages, facilities, equipment, etc.) would be used through closure. Passive institutional controls (markers, engineered barriers, etc., that are not monitored or maintained) would be put in place during closure and used to minimize inadvertent exposures to members of the public in the future.

7.1.1 (11703)
<u>Comment</u> - EIS002312 / 0001
Why not use soda ash (refined) to plug the walls of the storage repository! Soda ash will let out heat, keep out water, keep in radioactive waste. Soda ash will not break down over long periods of time.

<u>Response</u>
The evolving design of the repository, as described in the Supplement to the Draft EIS and carried forward to the Final EIS, now includes a more robust waste package to delay by more than 10,000 years the release of radionuclides from the repository. The design also includes a titanium drip shield over each waste package to limit and moisture that could otherwise contact the waste packages. DOE also considered backfilling the emplacement drifts, but eliminated this concept because of its adverse impact on the cladding temperature of spent nuclear fuel. The design of the liner has evolved from an all-concrete liner to a combination of steel inverts with steel sets and welded-wire fabric with grouted rockbolts (see the Supplement to the Draft EIS and the Final EIS). DOE abandoned the all-concrete concept due to concerns about the long-term impacts of the concrete on the alkalinity of the drift environment, and the potential for corrosion of the engineered barrier and waste package components. In addition, DOE considered near-field treatment of rock in the repository design, as discussed in Section E.2.2.17 of the EIS. The rock treatment would inject a low-permeability grout into cracks in the rock above each emplacement drift to limit the amount of water that could seep into the drift.

The use of soda ash for plugging the walls of the repository, whether as a backfill or a rock treatment material, would raise the alkalinity of the repository environment. In addition, the use of soda ash as a backfill would have an adverse effect on heat removal and cladding temperatures. DOE would continue to refine the design of the engineered barrier system to reduce the creation of preferential pathways for water to contact the waste packages and to reduce the migration of radionuclides through existing pathways.

7.1.1 (12380)
<u>Comment</u> - 010073 / 0005
Table S-2 - The SDEIS offers no explanation of the need for up to 4 times as much electrical energy and 5 times as much waste generation for the lower temperature alternative than the DEIS design.

<u>Response</u>
Both the higher-temperature and lower-temperature operating modes of the flexible design use electrically powered fans for forced-flow air cooling to the emplacement drifts. The number of fans operating would gradually increase from the start of emplacement to the completion of emplacement when all fans had been placed in operation. The fans would continue to operate during monitoring for up to 300 years, depending on the specific scenario. The Draft EIS scenarios included much smaller fans for ventilation only, and did not include the operation of fans to cool the emplacement drifts. The substantially increased capacity of the fans, and the operation of the fans for up to 300 years, are the reasons that the use of electrical power for the flexible design scenarios is greater than the electrical use for the design in the Draft EIS.

The commenter refers to the upper range of construction and demolition debris generated under the lower-temperature operating mode; 810,000 cubic meters compared to 150,000 cubic meters under the Draft EIS thermal load scenarios. Section 3.1.12 of the Supplement to the Draft EIS discusses waste generation, as does Section 4.1.12 of the Final EIS. This section explains that the largest waste volumes would result from the lower-temperature operating mode with surface aging of waste. Additional waste would be generated from the construction and demolition of the surface aging facility and 4,500 dry storage vaults.

7.1.1 (12432)
<u>Comment</u> - EIS000817 / 0075
"Dry storage units are simpler and easier to maintain." What is the basis for this statement? You mean than aging pools? Are they really? Do you realize the huge number of problems with dry cask so far? At least in a pool you can see the assemblies. You know what is happening with them and with the water. You have access to them to

change situations. This idea that once in a cask, everything is fine, is based on nothing -- just predictions. You don't really know.

Response
Dry storage casks such as those in use at commercial facilities would not be used at the repository. In the unlikely event that the waste would be retrieved from the repository, the Alloy-22 waste packages would be brought to the surface and stored in dry storage units.

The Nuclear Regulatory Commission has concluded that above-ground dry storage is a viable option at commercial plants. Dry storage units are described as "simpler and easier to maintain" than pool storage because they provide passive cooling of spent nuclear fuel, as well as shielding. Unlike spent nuclear fuel pools, dry cask storage requires no treatment equipment to keep the pool water clean, involves no filtration, and generates no radioactive waste while maintaining shielding and allowing the spent nuclear fuel to cool.

The problems referred to by the commenter are widely documented in Nuclear Regulatory Commission bulletins, inspection reports, letters, and other public documents. The problems involve the use of a storage technology that uses a mostly carbon-steel fuel basket (internals and shell) with anti-corrosion coatings. The majority of the spent-fuel-storage technologies use stainless steel and either no or limited amounts of anti-corrosion coatings. Many of the problems cited resulted from a failure of the licensee to adequately implement the required quality assurance and quality control programs.

7.1.1 (12606)
Comment - EIS000817 / 0033
Your term "incident free" sounds like a sale -- nothing is really "free" -- expect "incidents" -- there will be some, and I expect faulty fabrication of casks and poor designs and handling procedures for casks to provide the biggest doses to workers and the public. These designs are new, vendors are new, subcontractors are not used to nuclear QA criteria, etc. -- a perfect setup for problems. And we already have a lot in dry cask storage at plants. The track record is bad already!

Response
The design, fabrication, and handling of waste packages are subject to the same level of peer review, public review, and regulatory review as the rest of the repository program. The waste packages would be fabricated under the American Society of Mechanical Engineer's Section III nuclear codes (DIRS 145103-ASME 1998). This approach has been successfully used in the past to ensure high-quality components. Dry cask storage at commercial plants is designed for interim (about 100 years) storage above ground, not for underground disposal. The waste package that would be used at the repository would far exceed the performance and reliability of waste containers currently used for dry cask storage at commercial sites.

7.1.1 (13373)
Comment - 010182 / 0016
The SDEIS states that titanium drip shields will be constructed on site and placed over the waste packages after emplacement. It states that titanium is extremely corrosion resistant; however, on Page 3-19, para. 3.1.15 "Offsite Manufacturing," it states that titanium is "somewhat difficult to refine into metal." The installation of drip shields at the time of repository closure may result in transportation of shields to the site over a relatively short period of time rather than during emplacement; and the cost of drip shields will be deferred. This does not seem to be consistent with protecting the waste packages and ultimately protecting the public and environment from potential escape of radionuclides during emplacement. If the drip shields are emplaced during waste package emplacement, will funds be available when needed? The SDEIS should consider:

a. An analysis, now, on the ability for the DOE to mass produce the drip shields presently, and on the cost to produce and install the drip shields at time of waste package emplacement;

b. The transportation accident and fatality risk associated with a short-duration campaign to ship drip shields to the site; and

c. A mitigation measure to include installation of drip shields at time of waste package emplacement.

Response

DOE believes that Congress, having directed the Government to embark on this project, will continue to fund it adequately to protect the public health and welfare. As reported in *Nuclear Waste Fund Fee Adequacy: An Assessment* (DIRS 153257-DOE 2001), the Nuclear Waste Fund investments had a market value of $8.5 billion as of September 30, 1999. The report found that the current fee of 1 mil per kilowatt-hour charged to generators of commercial spent nuclear fuel was adequate to cover projected disposal expenses (including costs associated with packaging and transportation and updated to include a variety of operating modes and closure modes, including drip shields, and schedules for the flexible design) and recommended that the fee remain unchanged.

Response to comment subparts:

a. Section 2.15 of the EIS describes the results of the estimates to produce, deliver, and install the drip shields. The report *Life Cycle Cost Analysis for Repository Flexible Design Concepts* (DIRS 156900-DOE 2001) is based on the TSLCC and contains cost estimates for the 70,000 MTHM Proposed Action. Section 2.4.4 of the Science and Engineering Report (DIRS 153849-DOE 2001) describes the feasibility of using drip shields.

b. The transportation accident and fatality risk associated with transporting drip shields to the repository has been added to the Final EIS transportation analysis. See Section 6.1.3 of the EIS for more information.

c. During the preclosure period the repository is ventilated. Also the newly emplaced packages are at their highest heat output. During this preclosure period there is no dripping from infiltrating water due to the de-watering effect of the heat output and the ventilation. Under these conditions only humid air corrosion would take place. The drip shields' only purpose is to prevent liquid water from dripping on the waste packages so that liquid water corrosion effects are prevented. Prior to closure there is no dripping and therefore no need for the drip shields.

7.1.2 SUPPLEMENT TO THE DRAFT EIS FLEXIBLE DESIGN

7.1.2 (2249)

Comment - 010212 / 0005

One of the changes from the DEIS design is to have one canister transfer line instead of two, based on "further waste stream requirements analysis," and a reduction from three to two assembly transfer lines. We have not read the reference for those changes but we are curious about reducing redundancy to account for maintenance or equipment malfunction. We recommend that redundancy of equipment be a design parameter, as we understand it is one of the hallmarks of the nuclear industry's excellent safety record.

Response

Operation, preventive maintenance, and the repair of malfunctions at the repository would be part of the detailed engineering process during License Application, if the Yucca Mountain site was designated for the repository. The difference in the number of processing lines between the Draft EIS and Final EIS was based on the planned level of operation and the rate at which the flexible design would handle the waste stream. If it was determined that malfunctions in the transfer lines would be likely to impair the ability to meet processing requirements successfully, design alternatives, including redundant capability, would be considered.

7.1.2 (12362)

Comment - 010491 / 0002

The use of titanium as a roof over the waste inside the repository only makes the repository more attractive commercially to tomb robbers.

Response

Under the advice of the National Research Council of the National Academy of Sciences, the Environmental Protection Agency elected to exclude considerations of deliberate human intrusion from the final repository performance standard (40 CFR Part 197). This is primarily because it is impossible to characterize any range of deliberate acts of humans in the future and also because of the long period of administrative control. However, DOE did evaluate potential impacts of an inadvertent human intrusion in a manner required by the Environmental Protection Agency's recent *Public Health and Environmental Radiation Protection Standards for Yucca Mountain,* *Nevada* (40 CFR Part 197) to gain insight into the robustness of the repository design. The result reported in the Draft EIS was one-fifteenth of the standard set by the Environmental Protection Agency. The Final EIS includes an updated version of this analysis.

7.1.2 (12654)
Comment - 010099 / 0004
It is not clear that the "S&ER flexible design" discussed in the SDEIS is the same as that used in the TSLCC document which uses a "Reference System Design" ("capable of emplacing 97,000 MTHM") from a "Project Description Document" not made available to the public. The FEIS should clarify this.

Response
The commenter is correct in noting that the flexible design is not the same as the reference design referred to in *Analysis of the Total System Life-Cycle Cost of the Civilian Radioactive Waste Management Program* (DIRS 153255-DOE 2001). The flexible design includes the reference design as the higher-temperature operating mode. The other operating modes of the flexible design, referred to as lower-temperature operating modes, were discussed generally in Chapter 8 of DOE (DIRS 153255-2001). The *Life Cycle Cost Analysis for Repository Flexible Design Concepts* (DIRS 156900-DOE 2001) is an update to the information provided in the May 2001 report and is for the full range of the flexible design for 70,000 MTHM. The estimated costs associated with the Proposed Action have been updated in the EIS (see Section 2.1.5).

7.1.2 (12690)
Comment - 010480 / 0002

The retrievability-
To maintain waste package retrievability. The drip shields would be placed over the waste packages just before repository closure.

What happens if the drip shield [gets] dripped on and becomes contaminated and possible melt down effect occurs? How can you retrieve them?

Response
Drip shields would be emplaced just prior to permanent closure of the repository. Therefore, their emplacement would occur only after satisfactory completion of the performance confirmation program which, under certain implementation options, could extend for more than 300 years after final emplacement of the waste packages. The purpose of the performance confirmation program is to ensure that the engineered barriers and the geologic setting are performing as predicted by the long-term performance models thus ensuring compliance with the Environmental Protection Agency's Human Health and Environmental Protection Standards (40 CFR Part 197) as well as the Nuclear Regulatory Commission's licensing criteria (10 CFR Part 63). Once the determination has been made that the repository is in compliance with the long-term performance standards, a license amendment would be prepared and submitted to the Nuclear Regulatory Commission requesting approval for permanent closure of the repository (possibly more than 300 years in the future). The drip shields would not be emplaced until approval to close the repository was received from the Nuclear Regulatory Commission.

The repository design allows for maintenance of systems and structures such that retrieval of the waste packages would be possible up to the time of permanent closure. After emplacement of the drip shields and closure of the repository, retrieval of the waste packages would not be expected or planned.

For a period after closure, the intrinsic heat of the waste packages would be sufficient to drive liquid moisture away from the waste packages and the drip shields. At some time in the future, the waste packages would cool to a point that allowed infiltrating liquid water to drip onto the drip shields. The purpose of the drip shields would be to prevent liquid water from dripping on the waste packages, which could increase corrosion rates and shorten the life of the waste packages. However, studies have determined that use of drip shields probably would ensure the integrity of the vast majority of the waste packages for more than 10,000 years.

With regard to drip shields becoming contaminated and undergoing a meltdown, DOE is not aware of any scenario related to dripping water that could produce such an effect.

7.1.2 (12959)
Comment - 010249 / 0013
Clarify the appropriateness of DOE's "criteria for repository area selection"

In Section 2.3.3 of the SDEIS, DOE introduces a set of criteria that are constraints on the location of the below ground repository (type of rock formation, proximity to faults, distance from the surface, and distance from the water table). It is not entirely clear that these criteria are necessary at this time. DOE should either remove these constraints from the FEIS or better explain the reason for imposing them.

Response
The criteria mentioned are part of the assumptions for the design basis for the flexible design. The criteria are imposed by the Yucca Mountain Project, not the EIS. The criteria for location of the repository are detailed in the Subsurface Facility Design Description Document that was referenced in the Supplement to the Draft EIS where the criteria in question were stated. The criteria are based primarily on requirements set forth in the Nuclear Regulatory Commission regulation for high-level waste disposal (10 CFR Part 63) which are then further detailed in DOE's Mined Geologic Repository Requirements Document. The repository must meet the requirements of this regulation in order to be licensed by the Nuclear Regulatory Commission. Further information on development of these criteria can be found in the design description document. The relationship of each of the criteria to the regulation and related rationale are as follows:

Location in the Topopah Spring Formation:
10 CFR 63.113(b) requires the repository to be within the TSw2 geologic unit. This is primarily because the rock in this unit has general properties favorable to containment and isolation.

Avoid major faults:
10 CFR 63.113(a) requires the geologic repository to include a natural barrier. Major faults represent potential preferential pathways and therefore are potential breaches of the natural barrier. Therefore a standoff distance is established between the repository openings and Type I faults to ensure the presence of a natural barrier.

Locate at least 200 meters below the surface:
This is related to 10 CFR 63.113(b) and stems from a requirement in the Mined Geologic Repository Requirements Document (Section 3.3.C) which states specifically that there will be an overburden of 200 meters for the perimeters of the drifts at the emplacement level. The rationale for this is primarily to maintain sufficient distance from human influence and the surface environment.

Locate at least 160 meters above the existing water table:
This is also related to 10 CFR 63.113(a) requiring natural barriers. This leads to the need for sufficient separation from the water table to avoid future climate conditions causing the water table to reach the level of the repository and sufficient separation from faults. Several lines of evidence point to a past waster table elevation at Yucca Mountain of at most 115 meters above the present-day level. It was also determined that better repository performance would be ensured if the water table remained below the farthest extent of boiling influence from the heat generated by the waste. Consideration of all these factors led to the 160-meter criteria.

7.1.2 (12960)
Comment - 010249 / 0014
Correctly reflect storage cask design standards

In Section 3.1.15 of the SDEIS, DOE makes the following statement regarding the carbon-steel shells in dry storage casks (in the 4th paragraph on p 3-19); "The shell... manufactured to less demanding procedures and specifications." This statement is not accurate. While the procedures and specifications are different, they are not necessarily "less demanding". In accordance with NRC [Nuclear Regulatory Commission] licensing requirements, these components are designed to withstand seismic events, provide natural convection cooling, and otherwise meet rigorous standards. This statement should be revised so as not to provide misleading information about the adequacy of the design.

Response
The statement has been revised in the Final EIS.

7.1.2 (13100)
Comment - 010227 / 0018
There are many questions that arise from the DOE study of the drip shields, as with much of this project, you don't really get any answers to your questions, just more questions. One of these questions that were not addressed in the SDEIS is where the drip shields would divert moisture? The images shown in the document show a slight railing along the shields, which would seem to be a gutter of sorts, yet there is no description of where this moisture would go -- possibly between the drift walls? Possibly back into fissures in the rock? It could potentially evaporate right off the drip shields depending on how hot those would be (but that information isn't in the SDEIS either); there is no clear answer to how these would really work to protect the environment from the waste.

Response
Section 2.3.4.3 "Emplacement Pallets" of the Supplement to the Draft EIS has a very brief discussion on drip shields with conceptual figures. For more details, see the Science and Engineering Report (DIRS 153849-DOE 2001). Figure 2-71 in that section illustrates the "ballast" support of the drip shield. This ballast would be engineered granular material that would absorb any dripping water. The runoff water would then be evaporated or trickle into the rock invert and its matrix of pores and fractures.

7.1.2 (13101)
Comment - 010227 / 0019
The SDEIS states that the drip shields would not be put into place until the repository closes -- what happens if that is more than 300 years away? The drip shields are designed to protect waste packages from possibly corrosion. If the waste packages are in place for 300 years before the drip shields are placed, that allows for 300 years of rainfall to corrode these packages. If the higher-temperature scenario becomes a part of the final design then there will still be 50 years before the drip shields go into place. According to the SDEIS 2.3.4.1 (p. 2-25) if the drip shields aren't in place water will drip onto the waste packages increasing the likelihood of corrosion. SDEIS does not adequately describe a method for preventing that corrosion until the drip shields can be put into place.

Response
During the preclosure period the repository would be ventilated. In addition, the newly emplaced waste packages would produce their highest heat output. During this period there would be no dripping from infiltrating water due to the dewatering effect of the waste-generated heat and from ventilation. Under these conditions only corrosion from humid air would take place. The purpose of the drip shields would be to prevent liquid water from dripping on the waste packages. Prior to closure there would be no dripping and, therefore, no need for the drip shields.

7.1.2 (13218)
Comment - 010244 / 0017
The SDEIS does not consider the potential for the Yucca Mountain geologic formation to accommodate spent fuel in amounts beyond that considered within the DEIS due to the closer spacing to be achieved through flexible design. The SDEIS should provide a new estimate of the total potential spent fuel and other high level radioactive waste that could be emplaced at Yucca Mountain.

Response
Under the NWPA, the repository is limited to 70,000 metric tons of heavy metal (MTHM) and the EIS evaluates the flexible design scenarios that support 70,000 MTHM. Based upon public comments during EIS scoping hearings, the EIS also evaluates the impacts of emplacing more than 70,000 MTHM in the repository (Inventory Modules 1 and 2) (see EIS Chapter 8 for a discussion of the inventories considered and the associated impacts). These inventory projections have not changed since the Draft EIS was published, but the impacts have been updated in the Final EIS to reflect the flexible design. The EIS does not contemplate inventories greater than those of Modules 1 and 2.

7.1.2 (13224)
Comment - 010244 / 0023
The SDEIS does not address the fact that the Drip Shields will not be employed until repository closure leaving the waste packages unprotected for up to 300 years under the lower temperature repository scenario.

Response
During the preclosure period the repository would be ventilated. During this time the waste packages are at their highest heat output (under all operating modes). During this preclosure period there would be no dripping from infiltrating water due to the de-watering effect of the heat output and the ventilation. Under these conditions only humid air corrosion would take place. The drip shields' only purpose is to prevent liquid water from dripping on the waste packages so that corrosion is prevented. Prior to closure, there is no dripping and, therefore, no need for the drip shields.

7.1.2 (13236)
Comment - 010244 / 0035
The repository would have two evaporation ponds for wastewater, one at each portal. In both ponds it is suggested that heavy plastic liners would prevent water migration into the soil. The North Portal Area would also include a 32-acre storm water retention pond. Increases of roughly 10% for the S&ER design is projected due to additional blow down and water for the 5,000 MTHM cooling pool. The supplement [provides] no proof that the plastic liners would survive during the 300 years it would take to close the lower-temperature repository design, which could possibly cause the release of radionuclides.

Response
Neither of the evaporation ponds would be needed or operated during the entire preclosure period. The evaporation pond at the South Portal would be used for excess water returned to the surface during subsurface excavation. This excavation would take place during the 5-year construction phase and for the first 22 years of the operation and monitoring phase, which includes simultaneous development (emplacement- and access-drift construction) and emplacement. That is, the South Portal evaporation pond would be used for a total of about 27 years. The evaporation pond at the North Portal would be used only during that portion of the operation and monitoring phase when waste was being emplaced in the repository and surface facilities were needed to support those actions. For most operating scenarios, emplacement would completed in 24 years. The exception would be if a surface aging facility were included; in such a case, it would be another 26 years before all of the waste was put into the subsurface repository. Maintenance (including replacement, as appropriate) could be necessary to keep these liners intact during their operational life, but they would not be expected to be in use during the caretaker and monitoring period, which could be as long as 300 years under several of the lower-temperature operating modes.

7.1.2 (13272)
Comment - 010231 / 0006
Page 2-13, Figure 2-4. The "potential commercial spent nuclear fuel aging area" is inside the RCA but apparently outside the security station. What security controls will there be for this area?

Response
To avoid compromise, details of physical security plans are typically not made available to the public. However, DOE believes that security for the spent nuclear fuel surface aging facility would be similar to that required for existing commercial Independent Spent Nuclear Storage Facilities currently licensed by the Nuclear Regulatory Commission. At a minimum, security controls would include positive control on ingress and egress at the facility, as well as periodic surveillance by security personnel. Detailed security requirements for all areas of the proposed repository, including the fuel aging facility, would be included in the construction and operating license approved and issued by the Nuclear Regulatory Commission.

7.1.2 (13274)
Comment - 010231 / 0008
Page 2-31, Section 2.4. The last two sentences of the fourth paragraph state: "The effect of drift spacing on these related parameters would be less than the effect of waste package spacing in the analytical scenarios presented in this Supplement. Therefore, DOE did not perform a quantitative evaluation of the environmental impacts of variable drift spacing." EPA questions the basis for this statement and conclusion. What about interactions? The

distance between waste packages is an independent design factor from the distance between drifts. Therefore, there is a range of potential conditions and impacts that could occur. These impacts should be assessed or a more detailed rationale provided for the statements and conclusion.

Response
The Final EIS is based on the flexible design described in detail in the Science and Engineering Report (DIRS 153849-DOE 2001). Thermal management of the proposed repository would involve complex, nonlinear relationships among many parameters of the repository system [see the Science and Engineering Report (DIRS 153849-DOE 2001) for further discussion]. The major determinants of the peak temperatures are the age of the fuel at emplacement, the linear heat load along each drift, and the ventilation period after emplacement. By keeping the drift spacing constant, the overall feasibility of the various repository operating modes can be evaluated. The analysis presented in the Science and Engineering Report supports the environmental impact conclusions in the EIS. The Science and Engineering Report recognizes that the thermal load or areal mass loading can be varied also by the liner thermal load (which was done in the Science and Engineering Report), the drift spacing (which was not done in the Science and Engineering Report), or both. By varying the fuel age, waste package spacing, and ventilation, DOE has considered the major factors that would affect temperature variations in the repository. As noted in both the Science and Engineering Report and the Supplement to the Draft EIS, future studies could include variations in drift spacing. At present, DOE does not expect the conclusions drawn from the analysis in the Final EIS to change substantially as a result of variations in drift spacing versus waste package spacing.

7.1.2 (13275)
Comment - 010231 / 0009
Page 2-31, Section 2.4. The first sentence of the final paragraph identifies "Uncertainties in future funding profiles or the order of...waste shipments" could affect the construction of the repository. The next sentence states that this approach could "potentially increase confidence in meeting the schedule for waste receipt and emplacement." DOE should explain how uncertainties in funding can result in increased confidence for meeting the schedule.

Response
As mentioned in Section 2.4 of the Supplement to the Draft EIS, uncertainties in future funding or the order of waste shipments might require the repository to be developed in a sequential manner, such as constructing the surface and subsurface facilities in portions or "modules." This approach would incorporate "lessons learned" from initial work into subsequent modules, reduce the initial construction costs and investment risk, and potentially increase confidence in meeting the schedule for waste receipt and emplacement. The intent of this discussion was not to imply that uncertain funding would increase confidence.

7.1.2 (13329)
Comment - 010317 / 0009
The DEIS-S mentions the use of back-fill material but [it's] not clear what material will be chosen. The recommendation of the Yucca Mountain site should not be made until firm decisions have been made about … what back-fill materials will go where.

Response
Section 2.3.6 of the Supplement to the Draft EIS discusses using excavated rock from the storage area or another source. At present, the backfilling of emplacement drifts is not considered beneficial. Because only the ramps, shafts, mains, and miscellaneous openings are designated for backfill, only processed mined rock (welded tuff) has been selected for backfill material.

7.1.2 (13345)
Comment - 010296 / 0005
It is erroneous to assume that lowering operating temperature of the repository automatically eliminates corrosion problems. Operating-temperature management of individual canisters will be required to reduce corrosion problems.

Response
The management of waste package temperature to achieve thermal goals would be based on the established thermal blending requirements. This comment is correct in stating that each package would have to be "managed" or loaded

with a mixture of spent nuclear fuel that met the requirements. The performance of the repository system under a lower-temperature operating mode is discussed in detail in Section 2.1.5 of the Science and Engineering Report (DIRS 153849-DOE 2001). One tradeoff regarding thermal loads is the estimation of rockfall. At lower temperatures, the overall amount of rockfall probably would be lower, but the localized amounts of rockfall could be greater due to nonuniform temperatures along the drift. Another result of lower temperatures would be lower corrosion susceptibility and reduced uncertainty. However, aqueous processes would be initiated sooner. Each of the degradation mechanisms utilized to predict the performance of the waste package includes temperature as a variable. Thus, the response of the waste package to a set of thermal conditions is built into the models.

Although a range of thermal loads was investigated for the repository, waste package performance as evaluated by the expected maximum dose to the public would not vary greatly with thermal loading. See the *FY 01 Supplemental Science Performance Analyses* (DIRS 155950-BSC 2001) for further detail.

7.1.2 (13387)
Comment - 010296 / 0020
As Nye County understands it, people (workers, operators) would drive the waste packages along a railroad from the waste handling building down to the appropriate point in the main drifts. Then "the operators would leave" (back to the surface?) and remote controls (operated at the surface?) would:

a) Open the door to the intended emplacement drift;
b) Use the locomotive to push the waste package and its pallet into the drift;
c) Close the door (maybe);
d) Remove (by gantry) the loaded waste package from the transporter and onto the metal ground support;
e) Pull the locomotive and transporter out of the emplacement drift, and close the door behind;
f) Then the workers return and drive the locomotive and transporter back to the surface.

The details of these operations must be disclosed in the FEIS (or its supporting documentation) in order to fully evaluate the DOE's assessment of risk.

Response
A technical report entitled *Concept of Operations for Waste Transport, Emplacement, and Retrieval* (DIRS 155732-BSC 2001) was prepared in July 2001. One of the objectives of this technical report was to discuss the base case concepts of waste transport, emplacement, and retrieval operations and evaluate these operations relative to a lower-temperature repository design. Detailed discussions of all operations necessary to emplace the waste packages were presented.

7.1.2 (13392)
Comment - 010296 / 0021
Further, Nye County notes that there is no explanation of how contingencies in remote handling would be met and at what cost in time, money and risk. For example, what happens when:

- A chunk of rock gets lodged in the gantry equipment, or in the emplacement drift door?
- The locomotive dies during gantry operation;
- The gantry sets the package one foot forward or backward, or one foot to the side of where it should be;
- The above contingency is not discovered until emplacement of a subsequent package.
- Again, information regarding how contingencies in remote handling would be met must be included in the FEIS or its supporting documentation.

Response
Accidents are addressed in Section 3.1.8 of the Supplement to the Draft EIS and Section 4.1.8 of the Draft and Final EIS.

The Supplement to the Draft EIS addresses proposed changes to the concepts contained in the Draft EIS. The waste emplacement operations applied to the revised flexible operating mode are fundamentally the same as those described in the Draft EIS (see Section 2.1.2.2.3 “Waste Package Emplacement Operations”).

These types of off-normal events will be addressed as final design of the gantry is developed. Also, refer to “Broad Based Risk Analysis Subsurface Facilities” (DIRS 102707-CRWMS M&O 1998).

The isolation door control system will be equipped with redundant switches to indicate full open or closed position. Should the door not operate properly, the conditions would be investigated and appropriate mitigation strategies will be developed and initiated. Refer to “Emplacement Drift Isolation Door Control System” (DIRS 131504-CRWMS M&O 1998).

The locomotive and gantry are totally separate pieces of equipment that operate independently of each other. One failing will have no effect on the other.

Final Waste Package placement within the emplacement drift (waste package spacing) is a very important parameter. This separation distance between waste packages will be verified by two or more remote measuring technologies to ensure accurate package placement. Refer to “Gantry Structural/Control System Analysis” (DIRS 154553-BSC 2001).

7.1.2 (13397)
Comment - 010296 / 0022
Figure 2.2 (p.2-5): This is an artist’s conception of the nuclear waste repository rather than a scientist’s perception. The high temperature version of this figure (top) gives no indication where silica might precipitate relative to emplacement drifts, nor where dissolution of minerals caused by condensing steam (in refluxing zones) might occur. The precipitation of silica is important because it can control the flow of water (and gases) around and near the emplacement drifts. Silica precipitation could form a “gap” over the drift deflecting water around it, or it could precipitate between drifts causing flow into the drifts. If drifts are spaced too closely together, the silica caps could merge with adjacent drifts; low spots between drifts could accumulate infiltrated water causing a perched zone. Upon cooling, the blanket of silica precipitate could fracture and the perched water could then flow into the repository. Depending on the velocity of this flow into drift(s), steam explosions are possible. Nye County finds this overly simplistic “artist’s” conception of the repository to be inaccurate and misleading. The FEIS should identify all the natural processes that might occur within the repository and explain the potential consequences of these processes on repository performance.

Response
As indicated by Figure 2-2 of the Supplement to the Draft EIS, during the period of high heat output from the waste packages, expected water flow conditions for the higher- and lower-temperature repository operating modes would be dominated by the thermal effects of the waste packages. After the waste packages cooled, more complex thermal-hydrological-chemical interactions would affect the water in the drifts. This comment is correct to point out that those interactions are complex. Figure 2-2 is based on Figures 2-71 and 4-38 from the Science and Engineering Report (DIRS 153849-DOE 2001), which show the expected waste package emplacement and drift scale thermal-hydrologic flow and transport processes, respectively.

The overall long-term performance of the higher- and lower-temperature repository operating modes is described in Chapter 5 of the EIS. Long-term performance results include simulations of thermal-hydraulic-chemical processes in the Total System Performance model, which include coupling between heat, water, and vapor flow; aqueous and gaseous species transport; kinetic and equilibrium mineral-water reactions; and feedback of mineral precipitation or dissolution on porosity, permeability, and capillary pressure (hydrologic properties) for a dual-permeability (fracture-matrix) system (DIRS 155950-BSC 2001).

7.1.2 (13398)
Comment - 010296 / 0023
As stated in the DSEIS [Supplement to the Draft EIS], the drip shield provides an independent corrosion resistant barrier. Independent barriers provide confidence against unforeseen processes and failure modes that cannot be included in PA [performance assessment] calculations. However, the quantitative performance improvement

provided by the drip shields is unclear. Because the bottom is not sealed, moisture can theoretically enter below the drip shields. Under some sets of conditions, this can lead to condensation forming on the inside of the drip shield. The drip shields would reduce, but not clearly eliminate, dripping on the waste package and waste. The waste package would still be exposed to deposits of dirt and salt prior to closure. This would allow corrosion of the Alloy-22 to begin prior to the failure of the drip shields.

Response
The current modeling of waste package degradation includes the processes cited in this comment. These are expected processes that are accounted for in the modeling of package degradation. Corrosion would proceed prior to failure of drip shields, but would be greatly retarded by their presence. Thus, while the drip shields would not be an absolute containment, like the waste package, they would provide protection for the waste package containment by greatly reducing corrosion processes and protecting packages from rockfalls as drifts deteriorated. DOE has taken a conservative approach to assessing drip shield and waste package performance. The analysis assumed that dripping water contacting the drip shields or waste packages would be concentrated in its contained salts due to evaporation and condensation processes or by the presence of deliquescent salts brought in by the ventilation system. Two types of water were evaluated (DIRS 153849-DOE 2001). These include J-13 well water, a bicarbonate water, and rock pore water, a chloride-sulfate water. Once a water film was present, the degradation model was activated for the outer surfaces of the drip shield and the waste package. Water that condensed on the underside of the drip shield was assumed to be relatively pure. Such condensation on the drip shield would be possible but it was not observed in pilot-scale testing at thermal conditions similar to those of the repository. See Section 4.2.5.1 of the Science and Engineering Report (DIRS 153849-DOE 2001).

Sensitivity analyses were performed for each of the barriers [see Section 4.5.3 of the Science and Engineering Report (DIRS 153849-DOE 2001)]. The drip shield would provide some defense-in-depth for the case of a degraded waste package. Mean dose rates would increase by about a factor of 10; however, mean dose rates at the 10,000-year regulatory period would still be low.

7.1.2 (13399)
Comment - 010296 / 0024
Alloy-22 "feet" are to go on the drip shields purportedly to prevent galvanic coupling with the underlying steel members. While this may reduce the potential for galvanic coupling and hydrogen accumulation, it will not prevent it.

Response
DOE agrees that the use of Alloy-22 feet on the drip shield would not entirely eliminate galvanic coupling. This could accelerate the generation of insoluble ferric oxides or oxyhydroxides. However, Alloy-22 and Titanium Grade 7 have very similar corrosion potentials in repository-relevant solutions (compare DIRS 144971-CRWMS M&O 2000, Table 4, to DIRS 144229-CRWMS M&O 2000, Table 4). Therefore, galvanic coupling between Alloy-22 and Titanium Grade 7 would be of little consequence to degradation characteristics.

Hydrogen can evolve when passive alloys such as titanium are galvanically coupled to more active metals such as carbon steel. A consequence of hydrogen evolution could be hydrogen induced-cracking of repository materials. In the current repository design (including features such as the Alloy-22 feet), the titanium drip shield would not be in contact with any more active metals intentionally. Hydrogen embrittlement of alloys such as the Titanium Grade 7 drip shield occur when three general conditions occur simultaneously:

- A mechanism for generating hydrogen on a titanium surface
- Metal temperature above approximately 80°C (175°F)
- Solution pH less than 3 or greater than 12, or impressed potentials more negative than -0.7 V (SCE)

In the current repository design a mechanism for generating hydrogen could occur through galvanic coupling between the titanium drip shield and steel structural components (rockbolts, etc.) that could fall on the drip shield. In addition, conditions two and three would be met at certain repository locations where temperatures were high [80°C (175°F)] and concentrated groundwater was present. If all three conditions were present at the same time, local hydrided "hot spots" could form.

Despite the potential for local hydrided hot spots, significant hydrogen embrittlement of Titanium Grade 7 would be unlikely. The drip shield would have a large "tolerance" for hydrogen; that is, substantial concentrations would have to be achieved before any degradation in fracture toughness was observed. The critical hydrogen concentration level has been suggested to be at least 400 micrograms per gram and is likely to be well in excess of 1000 micrograms per gram (DIRS 154666-CRWMS M&O 2000). The estimated hydrogen concentration in the drip shield from passive corrosion 10,000 years after emplacement would be about 257 microgram per gram from a conservative estimate and 58 micrograms per gram from a best estimate (DIRS 151599-CRWMS M&O 2000). This would be well below the threshold concentration, and would not result in any noticeable hydrogen embrittlement or degradation of fracture toughness.

7.1.2 (13400)
Comment - 010296 / 0025
Alloy-22 should increase the time to first penetration of the waste package in comparison with the Draft EIS design. It is unclear whether DOE has sufficient data or theoretical models to justify taking performance credit for the material.

Response
The commenter is referred to Section 4.2.4 of the Science and Engineering Report (DIRS 153849-DOE 2001), Section 7 of the *FY 01 Supplemental Science and Performance Analyses* (DIRS 155950- and 154659-BSC 2001) and several other supporting documents referenced in the EIS for extensive detail concerning data and models used to forecast the behavior of Alloy-22. In particular, Section 7 of the Supplemental Science and Performance Analyses examines the uncertainties in extensive detail. Sensitivity analyses provide estimates of the importance of this uncertainty to the overall performance forecast. The information supports considerable confidence that while the range of possible behavior is great, use of this material supports a range of outcomes in performance in which all values lie well below accepted performance standards.

7.1.2 (13401)
Comment - 010296 / 0026
Placement of the drip shields is scheduled far in the future (at time of closure). Given the proclivity of Congress to play games with federal programs, what confidence can one have that the shields will ever be placed? Corrosion of the drip shields occurs in parallel with Alloy-22, rather than in series. Why not affix the titanium so that it is present from the start, corrodes in series with the waste package, and protects the waste package from initial dirt and salt deposits?

Response
During the preclosure period, the repository would be ventilated. Also, the newly emplaced waste packages would be at their highest heat output. During this preclosure period, there would be no dripping from infiltrating water because of the dewatering effect of the heat output and repository ventilation. The air would be low in relative humidity, assisted through the use of active ventilation. The drip shields' only purpose at that point would be to prevent liquid water from dripping on the waste packages, thus preventing liquid-water corrosion effects. Before closure, there would be no dripping. During the preclosure period, the corrosion of the waste packages is very low; they withstand rockfall without failure. (See Section 4.2.3.2.5 of the Science and Engineering Report for further information.) Therefore, installing the drip shields early would have no technical benefit and would result in an early, but unnecessary, expenditure. The drip shields would provide defense-in-depth during the postclosure period.

7.1.2 (13402)
Comment - 010296 / 0027
As discussed in Section 2.3.4, Engineered Barrier Design, the switch from Alloy-22 inside to the outside of the canister, with stainless steel inside for structural support was justified by its greater performance. Once the outer shell of Alloy-22 is breached, the rusting of the inner stainless steel shell with accompanying volume increase of iron oxides will quickly destroy the remainder of the outer shell by deformation and cracking. Since at least 90 percent of the performance of the repository is based on the canister, and ongoing experiments on canister materials are not completed (specifically, the effects of trace elements such as lead), it seems premature to justify changes of this sort on performance assessment.

Response
The analysis took no credit for the stainless-steel sleeve, which it considered only as a structural reinforcement prior to a breach of the Alloy-22. Until the Alloy-22 was breached, the interface would be unwetted and not exposed to oxygen. Therefore, any damage to the passive layer would be of no consequence. After the Alloy-22 was breached, corrosion would proceed from the inside and such things as the presence of iron oxides would be accounted for.

The Final EIS contains a new analysis of non-nuclear toxic materials based on the new design of the repository and waste packages. The analyses show that even under very conservative and bounding assumptions, toxic materials would have no significant impacts during the compliance period. Further details are in Sections I.6 and 5.6 of the EIS. The purpose of the current research is to support a possible decision to construct and operate the repository with postclosure forecasts only for making a reasonably informed decision that a postclosure mode would be feasible. The operation of the repository would include contingency planning for continued performance monitoring, which could extend for up to 300 years after emplacement. During this period, research would continue, including tests of the materials of construction and refinement of forecasting techniques. DOE believes that by the time of closure there would be sufficient knowledge of canister integrity and other pertinent items to support the case for safe closure or some alternative action. However, DOE also believes that current research on these materials is sufficient to provide a level of confidence and understanding to inform a site recommendation decision. See Section 4.2.4.3 of the Science and Engineering Report (DIRS 153849-DOE 2001) for more information.

7.1.2 (13403)
Comment - 010296 / 0028
The DOE has not identified any potential problems with respect to engineered barrier materials. Specifically, Nye County is referring to the potential effects of trace elements on the canister material alloy, ALLOY-22. Tests being conducted by DOE are beginning with low temperature conditions (70°C) and working up to higher temperature conditions. Given that temperature increases reaction rates exponentially as temperature increases, DOE will not see any significant effect of trace elements until and unless they experiments are performed at sufficiently high temperatures (120°C and above). A better approach would be to look for an effect at high temperatures and work down to see at what temperature the effect is not observable. The FEIS should address the potential effects of trace elements on barrier material performance in the presence of high temperature conditions. Given that the first canister failures are currently projected to occur just after the 10,000-year regulatory period, the potential complications that might result from the presence of trace elements in the canister material under high temperature conditions should be addressed in the FEIS.

Response
The purpose of the current research is to support a suitability decision for the Yucca Mountain site, with postclosure forecasts only for making a reasonably informed decision regarding long-term performance and regulatory compliance. As required by 10 CFR Part 63, the operation of the repository would include performance confirmation activities that would continue until repository closure. During this period, research would continue, including tests of the materials of construction and refinement of forecasting techniques.

Dripping water could contact the waste packages after the repository radionuclides decayed. The water could become concentrated in dissolved salts due to evaporation of the water film, as on the waste package surface. The chemistry of the water is described in the Science and Engineering Report (DIRS 153849-DOE 2001, Section 4.2.4.2.4). Two types of water were identified: J-13 well bicarbonate water that becomes alkaline near saturation and a pore-type chloride-sulfate water that remains near neutral near saturation. Long-term corrosion tests and short-term electrochemical potential tests have been conducted with the J-13 well water. In the latter tests, predicted concentrations of trace elements were added. No significant differences in corrosion rate were observed in these tests. Testing with the pore water is planned.

DOE believes that by the time of closure there would be sufficient knowledge of canister integrity and all other pertinent items to fully support the case for safe closure or for some alternative action. However, DOE also believes that the current research on these materials is sufficient to provide a level of confidence and understanding to adequately inform the site recommendation decision.

7.1.2 (13404)
Comment - 010296 / 0029
Rock bolts, as identified in Section 2.3.4.2, Ground Structures, may focus water flow onto the drip shields, and ultimately the canisters, as a result of their radial style of emplacement. What is the effect of grout on the chemistry of any dripping water? What is its trace element content? The FEIS must address these questions or indicate that DOE is uncertain of how these factors might affect performance.

Response
The in-drift environments are defined based on many processes including interaction of seepage water with rock bolts and grout material. The modeling of in-drift environments is discussed in the EIS in Section I.2.3, and in various referenced supporting documents. The ground control system is described in the Science and Engineering Report, Section 2.3.4. The system includes steel sets with welded-wire fabric and fully grouted rock bolts. This system would degrade with time. The steel would form oxides or oxyhydroxides, which would not be deleterious to the drip shield or waste package, while the grout would slightly modify the water dripping through it. However, the testing of drip-shield and waste-package material has included a broad range of water chemistries, including concrete modified water. Water chemistries are described in Section 4.2.4.2 of the Science and Engineering Report. Essentially no differences were seen in the rates of corrosion for any of the water chemistries evaluated.

7.1.2 (13448)
Comment - 010296 / 0033
With respect to Cask Maintenance (page 2-13), the DSEIS states that "the DEIS assumed that there would be a CMF...at the YM site." In nearly two years, DOE hasn't located such a facility. Its function, Nye County assumes, is to clean and repair DOE-owned casks as delivered by private carriers. Such a facility would likely generate additional volumes of hazardous wastes (spent solvents, metal cuttings, etc.). It not clear whether the impacts from the CMF have been included in either the DEIS or the DSEIS.

Response
To transport spent nuclear fuel and high-level radioactive waste to the repository, DOE would use existing or new shipping casks that met Nuclear Regulatory Commission regulations (10 CFR Part 71). One or more qualified companies that provide specialized metal structures, tanks, and other heavy equipment would manufacture new shipping casks. The number and type of shipping casks required would depend on the predominant mode of transportation.

DOE would remove casks from service periodically for maintenance and inspection. These activities would occur at a cask maintenance facility(s) where cask functions and components would be checked and inspected in compliance with Nuclear Regulatory Commission requirements and preventive maintenance procedures. The major operations involved in cask maintenance would include decontamination, replacement of limited-life components such as O-rings, and verification of radiation shielding integrity, structural integrity, and heat transfer efficiency.

The large number of repository shipments would require new facilities for cask maintenance. DOE has not decided where in the United States it would locate a cask maintenance facility(s), but this EIS assumes that such a facility would be at the repository inside the Restricted Area at the North Portal on approximately 0.01 square kilometer (2.5 acres). Minor cask maintenance activities could occur at commercial or DOE sites.

7.1.2.1 Higher- and Lower-Temperature Operating Modes

7.1.2.1 (13086)
Comment - 010227 / 0004
In the higher temperature scenarios which were described in the SDEIS, drifts would be 81 meters apart, this is so that water moving through fast pathways would not pool above all of the drifts, and would instead find its way through the spaces between the drifts. The SDEIS seems to be telling people that there is no way to keep water from moving close to the waste packages (even with the fancy titanium drip shields) and that there are indeed fast pathways which can move water more quickly to the water table.

Response
The existence of fast pathways and the possible contact of water with the waste packages are all considered in the long-term performance models. The drip shields would keep dripping water from the waste packages for more than 10,000 years, which would greatly improve long-term performance. All of the concerns expressed in this comment are accounted for in the models used.

7.1.2.1 (13138)
Comment - 010237 / 0007
The S&ER flexible design allows for a degree of operator error if the wrong operating mode is selected.

Response
For the analyses performed for the Supplement to the Draft EIS, DOE developed analytical scenarios to estimate the range of potential environmental impacts that could result from the Proposed Action. These analytical scenarios include the low, intermediate, and high thermal load scenarios presented in the Draft EIS, as well as the higher-temperature and lower-temperature repository operating modes of the Reference Design. Section 2.2.1 of the Supplement summarizes the operational parameters for the three thermal load scenarios analyzed in the Draft EIS and the two repository operating modes analyzed in the Supplement. Section 2.2.2.2 describes the operational parameters for the higher- and lower-temperature repository operating modes. DOE developed these scenarios and operating modes to accommodate and maintain flexibility for the potential future evolution of the design of the repository. So as not to underestimate the impacts that could result from future design evolution, these scenarios and operating modes incorporate conservative assumptions. Sections 2.2.1 and 2.2.2 of the Supplement discuss the design and operational evolution, respectively, which was carried forward to the Final EIS.

7.1.2.2 Ventilation

7.1.2.2 (12717)
Comment - 010073 / 0021
Page 2-21 - The SDEIS estimates that as much as 145 times as much air will be moved through the S&ER flexible design. Why is the risk associated with ventilation related exposure pathways not 145 times greater? There appears to be an inconsistency in the analyses.

Response
Although a greater amount of air would be moved through the repository with the increased ventilation for some flexible design operating modes, the source of pollutants does not increase proportionally. The source remains approximately the same, slightly larger, between the low ventilation rate (0.1 cubic meter per second) and the higher ventilation rate [15 cubic meters per second (32,000 cubic feet per minute)]. As a result, the risk only increases a small amount.

7.1.2.2 (12935)
Comment - 010257 / 0001
The idea that ventilation shafts and fans can be operated and maintained for hundreds of years implies long-term social and political stability that has never been demonstrated before.

Response
DOE recognizes that an underlying assumption of the extended emplacement period is that institutional controls would have to be maintained for at least 300 years into the future and that these controls could only be administered by a government that possessed the resources and the desire to do so. The Department also recognizes that if a political upheaval, such as the one that recently occurred in the former Soviet Union, was to occur in the United States, the government could have difficulty protecting and maintaining the storage facilities. However, the analyses in the EIS have followed the general guidance for the prediction of the evolution of society provided by the National Research Council in *Technical Bases for Yucca Mountain Standards* (DIRS 100018-National Research Council 1995), in which the Committee on Technical Bases for Yucca Mountain Standards concluded that there is no scientific basis for predicting future human behavior. The study recommends policy decisions that specify the use of default (or reference) scenarios to incorporate future human behaviors into compliance assessment calculations. The analyses in the EIS followed this approach, based on societal conditions, as they exist today. In doing so, the analysis assumed that ventilation and other repository systems could operate for very long periods with

regular maintenance. The Department believes that these assumptions are appropriate when estimating impacts because of the inherent inability to accurately predict the future of social behavior.

7.1.2.2 (13097)
Comment - 010227 / 0015
The SDEIS indicates a huge increase in the need for ventilation, and increases the proposed number of ventilation shafts -- how will more shafts impact the drip shields? How will they impact the structural integrity of the overall repository design? These are issues that were not adequately addressed in the SDEIS.

Response
All ventilation shafts are located in access drifts separated from emplacement drifts by solid rock 20 meters (66 feet) or more in thickness. In addition, the drip shields would not be emplaced until the repository is ready for and been approved for closure. Therefore, there would be no relationship between shafts and drip shields. In addition, ventilation shafts are spaced 300 meters (980 feet) or more apart. Therefore, weakening of the overall integrity of the repository would be highly unlikely.

Supporting documents to the EIS such as the *Monitored Geologic Repository Project Description Document* (DIRS 151853-CRWMS M&O 2000), and other referenced supporting documents discuss such issues as shaft seal design. It has been established that the current technology for shaft sealing will provide for sufficient integrity of these sealed openings that they will behave as well as the host rock in long-term performance. The EIS relies on all of these supporting documents, including the Science and Engineering Report, to provide discussions of such supporting details.

7.1.2.2 (13219)
Comment - 010244 / 0018
The SDEIS should consider the extent to which increased ventilation results in an enhanced exposure pathway.

Response
Increased ventilation was considered in Section 3.1.2 of the Supplement to the Draft EIS. The Final EIS addresses the environmental impacts due to increased ventilation [15 cubic meters per second (32,00 cubic feet per minute)] in greater detail in Section 4.1.2.3 of the EIS.

7.1.2.2 (13234)
Comment - 010244 / 0033
DOE claims that it can reduce the maximum temperature in the host rock by extending the drift ventilation period with either active of passive ventilation. This process alone could require ventilation periods as long as 300 years after emplacement to ensure post closure temperatures. The Supplement provided no substantiated proof that such a system would last 300 years.

Response
Ventilation systems can be maintained for very long periods as demonstrated by deep mining operations and underground traffic tunnels. The proposed flexible design would include the maintenance, operational, and equipment-replacement features needed to continue operations for the period of operation needed.

7.1.2.2 (13260)
Comment - 010274 / 0002
If the drift rock is maintained at 205° [Fahrenheit]; and the ventilation fans are removing 70% of the heat; it means that the high level nuclear material is sustaining 30% more heat in the containers; with the ventilation system in full operation; which means that each container is generating 266.5° [Fahrenheit].

Any high school student can tell you that water boils at 212° [Fahrenheit].

So, if the ventilation system or another coolant system fails to operate; that means the containers can add an additional temperature of 70% to 266.5° [Fahrenheit]; comes to 1,865.5° [Fahrenheit].

So, if all the coolant and ventilation systems fail, a chain reaction will develop and each of the 11,000 to 17,000 containers can melt-down and explode.

Response
If the ventilation systems were not operating, the drift wall and waste package temperatures would increase. This event is discussed in the *Yucca Mountain Science and Engineering Report*, which discusses the impact of a ventilation shutdown for the lower-temperature repository operating mode (DIRS 153849-DOE 2001). It would take 2 to 3 weeks for the maximum drift wall temperature [96ºC (205°F)] to be exceeded. However, even assuming no ventilation for 15 years, the peak temperature of the waste package is analyzed in the Science and Engineering Report to be less than 460ºC (896°F). Because the waste package has been analyzed to not fail prior to 600ºC (1,112°F), waste packages would not release gases or material due to fans failing for at least 15 years, thus providing ample time to repair the ventilation system or retrieve the waste packages.

7.1.2.2 (13263)
Comment - 010274 / 0004
There are no oceans, lakes, rivers, or any other above ground means to provide coolant to the Yucca Mountain area. The major source is underground drinking water. That in itself should disqualify this site.

I was always of the opinion that the high level nuclear material inside the containers, will have to be vented (open the containers in order to release the (buildup) pressure; in order to keep them from exploding.

Response
The treatment of water from the fuel pools is discussed in Section 2.2.4.3.1 of the Science and Engineering Report (DIRS 153849-DOE 2001). As discussed in that section, liquid low-level radioactive waste would be treated, recycled, or stabilized for offsite disposal.

The design of the repository includes a cooling tower adjacent to the utility building to support heat rejection from the utility building systems, such as the building chillers. Water from the cooling tower, among other industrial streams such as water collected from dust control operations, would be collected in one of two evaporation ponds. The ponds would evaporate excess water from dust-control operations at the South Portal and wastewater from water treatment and cooling systems at North Portal surface facilities. Water from these industrial streams would not contain any radioactive or hazardous materials.

The design of the repository is still evolving. DOE would ensure that the industrial wastewater-evaporation system met all applicable design requirements (including development of adequate maintenance and inspection programs) and received necessary peer reviews. In addition, the Nuclear Regulatory Commission would review the design before licensing the repository.

Based on requirements for shipping casks and waste packages, no water would be permitted inside the containers. Thus, generation and buildup of hydrogen from radiolytic decomposition of water would not occur. In addition, the greatly reduced radiation fields from fuel that must be cooled 5 years prior to shipment would limit the generation of hydrogen even if water was present. The radiolytic gases produced from decay of the waste would be a small fraction of the total pressure of the system. This decay would not generate significant radiation damage to the waste packages. Even in the event of a ventilation system failure, the peak temperature of the waste packages would only rise to something less than 460°C (820°F). Because the waste package has been analyzed to not fail prior to 600°C (1,112°F), the waste packages would not have the potential to release gases or material due to fans failing for at least 15 years, thus providing ample time to repair the ventilation system or retrieve the waste packages. Thus, once emplaced, the waste packages would need to be vented to reduce internal pressures.

7.1.2.2 (13273)
Comment - 010231 / 0007
Page 2-21, Section 2.3.3.2. The second paragraph states that "this low ventilation rate [0.l cubic meter per second] would permit monitoring of the air stream exhausting from the drifts for leaks of radioactive material, but would not contribute significantly to removal of heat from the emplacement drifts." This is followed by a discussion of the higher ventilation rate [15 cubic meters per second (32,000 cubic feet per minute)] under the new flexible design, but there is no mention of monitoring. Does this mean that the flexible design does not allow for monitoring of the

exhaust air? If so, this raises public health and on-site safety concerns. The final design must include effective monitoring and a system to divert the air into high-efficiency filtering systems in case releases are detected.

Response
The flexible design does include monitoring of the exhaust air and the ability to filter the exhaust stream if radioactive contamination was detected. The design would comply with applicable health and safety requirements.

7.1.2.2 (13344)
Comment - 010296 / 0004
The footprint of the underground facility will need to be expanded considerably from 4.7 for HTOM to 10.1 for LTOM (Table S-1 of SEIS). Although these area requirements are less than those of the DEIS cases, Nye County believes that managing and designing a better ventilation system could reduce the area requirements substantially. Larger area of the footprint means more excavation, material used, and energy consumed. Therefore, increased repository size equals increased environmental impacts. Although Nye County believes that lower-temperature operating modes would enhance the long-term safety of the repository, the increased size and its environmental impacts in the short term are of significant concern.

Response
The commenter is correct in pointing out the trade off of repository size versus ventilation needs to achieve LTOM. If the Yucca Mountain site is recommended, these tradeoffs and others will be considered in detail to select the flexible design operating modes for the license application.

7.1.2.2 (13348)
Comment - 010296 / 0008
DOE needs to evaluate other design configurations where natural ventilation can be used. Nye County believes that with the heat of the nuclear waste and modification of the design, most of the ventilation can be provided by natural ventilation. Only a few areas of underground facility may need to have supplemental forced ventilation as needed for workers and operational safety reasons.

Response
The amount of air that will flow in the repository due to natural ventilation depends on the difference in elevation between the intake and exhaust openings, the resistance of the subsurface excavations to airflow and the difference in temperature between the atmosphere and the subsurface repository. The difference in temperature between atmosphere and the subsurface repository depends on the operating mode. A higher-temperature repository would result in the greatest temperature differential and would produce a more reliable, higher natural airflow. A lower-temperature repository design would produce less temperature differential and a less reliable, lower natural airflow. Because the use of preclosure ventilation is a means toward meeting thermal goals, the choice of a hot or cooler mode of operation will influence the amount of natural airflow that will occur. The resistance of the excavation to airflow is low because the excavations are large in diameter. There are no designed restrictions in the system that would preclude natural ventilation.

DOE recognizes that postemplacement natural ventilation could be used to reduce long-term repository temperatures as discussed in Section 2.1.4 of the Science and Engineering Report (DIRS 153859-DOE 2001). As a consequence, natural ventilation has been proposed in several lower-temperature operating scenarios for the repository. By extending the time during which loaded emplacement drifts are ventilated (both forced and naturally), the repository could be operated at lower temperatures with minimal increases in the disposal area. The latest repository design including the concept of natural ventilation has the flexibility to accommodate and take advantage of new information that might improve performance or reduce long-term uncertainties.

The design of the repository ventilation system is still evolving and the concept of natural ventilation is a design detail that may be further developed for license application. The DOE will design the ventilation system in accordance with all requirements and peer reviews will be performed as necessary. In addition, the Nuclear Regulatory Commission will review the final design before licensing the repository and ensure the design meets all requirements.

7.1.2.2 (13352)
Comment - 010296 / 0011
Overall ventilation will tend to dry out the repository horizon. However one can postulate several scenarios leading to condensate formation in the ventilation shafts. Transient condensate could theoretically enter fractures prior to drying out. Example 1: The initial thermal pulse would increase the partial pressure of water vapor in the circulating air. As the air rises it contacts cooler rock and expands as pressure drops in the shaft. Both processes cool the air, potentially leading to condensate formation. Example 2: During a summer thunderstorm the ambient relative humidity rises. Humid air is pulled into the ventilation system and contacts cooler rock, leading to condensation. Because the fans are located at the shaft exits (negative pressure system) the air expands as it enters the ventilation system, leading to additional cooling. Note that since preclosure ventilation is stated to be under positive pressure, which lowers the likelihood of condensation, current experience may not be a reliable guide to future performance. Has the potential for condensate formation in the ventilation system been fully evaluated?

Response
The potential for condensation formation is considered in the ventilation system. The design for the repository intake and exhaust shafts includes a collection sump at each shaft bottom. The sump provides a collection area for water entering the Subsurface Facility (including any potential shaft condensation) to collect for subsequent pumping to the surface.

Even though a thunderstorm may increase the ambient relative humidity, it will remain below 100 percent, a level necessary to begin condensation at a given temperature (dew point). The Subsurface Facility natural wall rock temperature exceeds the average dew point temperatures for Southern Nevada, therefore, wall rock condensation would not likely occur.

7.1.2.2 (13355)
Comment - 010296 / 0012
On page 3-4 it is stated that, “The use of natural ventilation rather than forced-air ventilation for some portion of the preclosure period would result in less than half of the radon released to the offsite public for that portion of the period.” This is the main reason that DOE needs to continue to strongly evaluate the potential of a naturally ventilated repository.

Response
DOE recognizes that postemplacement natural ventilation could be used to reduce long-term repository temperatures as discussed in the Science and Engineering Report (DIRS 153849-DOE 2001). As a consequence, natural ventilation has been proposed for some lower-temperature operating mode scenarios. By extending the time during which loaded emplacement drifts were ventilated (both forced-air and naturally), the repository could be operated at lower temperatures with minimal increases in the disposal area. The latest repository design, including the concept of natural ventilation, has the flexibility to accommodate and take advantage of new information that could improve performance or reduce long-term uncertainties.

The design of the repository ventilation system is still evolving, and the concept of natural ventilation is a design detail that could be developed further for license application. DOE will design the ventilation system in accordance with all requirements, and peer reviews will be performed as necessary. In addition, the Nuclear Regulatory Commission will review the final design before licensing the repository and will ensure that the design meets all requirements.

7.1.2.3 Spent Nuclear Fuel Aging

7.1.2.3 (13134)
Comment - 010237 / 0003
Surface aging will increase the release of radiation to the environment and should not be used.

Response
Onsite aging would increase direct radiation exposures slightly at the repository; these exposures have been included in the Final EIS (see Table 4-25). However, because of the lower population density (public) and the larger distance between the surface aging facility and workers (both involved and noninvolved), the net collective dose from the

surface aging facility at the proposed repository over the 50-year aging period would be less than leaving the spent nuclear fuel at the generator sites for the same period (see Chapter 7, Table 7-6).

7.1.2.4 Waste Package Spacing

7.1.2.4 (13099)
Comment - 010227 / 0017
Where to put the waste packages -- this seems to be a question plaguing not only DOE, but most of the nuclear power industry as well. The SDEIS looks at a number of options for how to space the waste packages to keep temperatures within range, yet there is no mention of how those either closely spaced or widely spaced packages might create more of a hazard. There was no mention in the SDEIS of how waste package spacing could be impacted by accidental bombings from Nellis bombing range (the air force has a history like DOE -- and doesn't always get exactly what it's aiming for), or terrorist activity.

Response
Waste package spacing would be unrelated to the repository hazard as long as drift temperatures were controlled within acceptable limits. Accidental bombings from Nellis Air Force Base operations would not impact the waste packages because of the approximately 1,000-foot-thick rock overburden.

7.1.3 WASTE PACKAGE DESIGN

7.1.3 (717)
Comment - EIS000211 / 0002
The DEIS fails to address the fact that the number of shipments and the amount of radioactive material that will be shipped is unprecedented in world history. About 90% of the volume would be spent fuel from nuclear power plants, and virtually none of this type of material has ever been shipped before. Not only is it not known what type of container would be used to transport nuclear waste, but also these containers have been neither constructed nor tested -- therefore, the impact statement is incomplete.

Response
DOE does not agree that shipping large quantities of radioactive material is unprecedented. More than 2,700 shipments of spent nuclear fuel have been transported over about 2.6 million kilometers (1.6 million miles) of U.S. highways and railways without a breach of a shipping cask.

The Nuclear Regulatory Commission requires that the design of transportation casks for spent nuclear fuel and high-level radioactive waste meet very stringent standards (10 CFR Part 71). Casks must be able to survive, among other things, a drop of 9 meters (30 feet) onto an unyielding surface. See Section M.4 of the EIS for additional information on cask testing. Post-test analyses have found that, had the casks been filled with waste, they would not have released their contents. Many of the cask tests greatly exceed the test requirements of the Nuclear Regulatory Commission.

7.1.3 (3609)
Comment - EIS001031 / 0015
Do any fool-proof fuel containers exist for the storage, shipment or the permanent disposal of the wastes? Have these containers had full-scale tests? If radioactive gas leaks out, wouldn't it go around the world?

Response
Containers for the storage and transportation of spent nuclear fuel are in use in the United States and many other countries. Storage systems, regulated by the Nuclear Regulatory Commission (10 CFR Part 72), have been in use for about 10 years. Several commercial utilities have placed spent nuclear fuel in such systems. Transportation casks, also regulated by the Nuclear Regulatory Commission (10 CFR Part 71), have been used in more than 2,700 shipments of spent nuclear fuel. The Nuclear Regulatory Commission has certified a number of tests on casks. See Section M.4 of the EIS for additional information on cask testing.

DOE is designing containers for the permanent disposal of spent nuclear fuel, which the EIS refers to as waste packages. Samples of candidate metals for waste packages are undergoing laboratory tests. Full-diameter, one-third-length mockups of different waste packages have been built to demonstrate techniques for welding lids to packages. Full-scale prototype testing of waste packages could also be necessary.

To DOE's knowledge, there has been no leakage from the storage casks and transportation casks currently in use. If a cask's seal was breached, virtually all of the radioactive material (with the exception of noble gases) would remain in the cask. In theory, when noble gases are released to the atmosphere, they remain there indefinitely because of their nonreactive nature. However, the small quantities of these gases that could be released from failed or damaged waste packages would be quickly diluted in the atmosphere to concentrations well below those likely to result in adverse human health impacts.

7.1.3 (4209)
Comment - EIS001160 / 0023
The DEIS does not adequately address issues raised and substantiated by White Pine County during the scoping process. For example:

The repository EIS must include a comparative evaluation of the extent to which alternatives for accomplishing construction, emplacement, closure, and post-closure phases of the facility achieve containment of radioisotopes during volcanic eruption, earthquakes, and loss of criticality control. The comparative evaluation of alternatives for repository design, construction and operation should consider the full spectrum of uncertainty attendant to such options. In this way, the EIS should facilitate decision-making under conditions of uncertainty. The DEIS does not provide a comparative analysis in a useful summary form of the extent to which construction design and operational alternatives provide containment of radioisotopes from the accessible environment. It is not easy to conclude from the information in the document which design and operational alternative is preferred.

Beyond construction of the repository, alternative methods for conducting waste emplacement operations should be considered. Critical issues include candidate materials from which waste packages might be fabricated and alternative materials for fabrication of waste package baskets. The DEIS does not appear to consider technology alternatives or material choice in construction of waste packages.

Response
The EIS examines the impacts of the Proposed Action (to construct, operate and monitor, and eventually close a repository at Yucca Mountain), and the No-Action Alternative (maintain the wastes at existing generator and storage sites). The EIS does not provide, nor was it intended to provide, the basis for deciding on a final repository design (see Section 2.1.1.5 of the EIS). Rather, the EIS provides a range of design alternatives that DOE believes reflect a range of environmental impacts that could reasonably be expected to occur from any combination of design alternatives. Since publication of the Draft EIS, several enhancements have been included in the design of the repository to improve performance and reduce uncertainties. These enhancements include a more robust waste package, a titanium drip shield that would cover each waste package, and various ways to manage heat. This evolving design was described in a Supplement to the Draft EIS that was released for public review in May 2001.

If Yucca Mountain was recommended for further development as a geologic repository, the Nuclear Regulatory Commission would review the design concepts and performance predictions before granting DOE a license to begin construction. The final design would be described in the License Application. Environmental impacts associated with that design would be addressed as part of the License Application for construction authorization. During the licensing process, DOE would evaluate design alternatives and options in greater detail, as necessary, to demonstrate compliance with requirements of the Nuclear Regulatory Commission. The expected environmental consequences of the final design would have to have been adequately bounded by the consequences described in the Final EIS.

The Final EIS includes updated models for seismic events including those that could result in cladding damage. Nevertheless, modeling indicates that waste package failure would not increase greatly. The most likely results of seismic shaking are rocks falling from the ceilings of the emplacement rooms that could breach the waste packages. The updated analysis of seismic-induced rockfall for the flexible design indicates that during the first 10,000 years, the titanium drip shields covering each waste package would be expected to provide adequate protection from rockfall. After 10,000 years, the collapse of tunnels would preclude rocks from falling because the ceilings would rest on or near the drip shields and waste packages. In conclusion, damage to waste packages from seismic shaking would be unlikely. Potential impacts associated with other disruptive events, such as volcanic eruptions and human intrusion, have been updated for the flexible design and are presented in Chapter 5 of the EIS.

Consistent with National Academy of Science observations, DOE has designed performance assessments on a combination of mathematical modeling, natural analogues, and the possibility of remedial action in the event of unforeseen events. DOE confidence in the disposal techniques is based on defense-in-depth that, for example, places drip shields over waste packages to account for uncertainties. DOE adopted an assessment approach that explicitly considered the spatial and temporal variability and inherent uncertainties in geologic and biological components. The bases of the approach are summarized as follows:

- Site description is based on extensive underground exploratory studies and investigations of the surface environment.
- Reference design is based on laboratory investigations and conceptual engineering studies.
- Features, events, and processes that could effect the long-term safety of the repository are identified.
- Evaluation of a wide range of exposure scenarios, including the normal evolution of the disposal system under the expected thermal, hydrologic, chemical, and mechanical conditions; altered conditions due to natural processes such as changes in climate; human intrusion or actions such as use of water supply wells, irrigation of crops, exploratory drilling; and low probability events such as volcanoes, earthquakes, and nuclear criticality.
- Development of alternative conceptual and numerical models to represent the features, events, and processes of a particular scenario and to simulate system performance for that scenario.
- Parameter distributions to represent the possible change of the system over the long term and use of conservative assessments that lead to overestimating of impacts when there is insufficient information for use of a probability distribution.
- Performance of sensitivity analyses.
- Extensive peer review and oversight.

DOE believes this process resulted in a representative estimation of impacts and is sufficient for comparing the relative merits of the various repository scenarios, including the preferred alternative. The Department continues to evaluate the sufficiency of its approach of dealing with uncertainty at the process level (scientific) as well as the system-level of modeling. A task force has been organized to review and outline further work to be completed on uncertainties before the time of license application, should the repository be recommended as a suitable site.

7.1.4 WASTE PACKAGE MANUFACTURING

7.1.4 (2190)
Comment - EIS000765 / 0005
My suggestion involves the disposition of some 6000 tons of DOE-owned radioactively-contaminated scrap nickel which was removed from DOE’s uranium enrichment plants. DOE has decided not to release this nickel to the market for recycle. My suggestion is that DOE earmark this nickel for the fabrication of the corrosion-resistant inner layer of the disposable waste packages to be placed in the waste repository. In that manner DOE uses a resource that it already owns, the contaminated nickel is managed safely, and the issue of contaminated scrap metal getting into the public sector is totally avoided.

Response
Surplus nickel has been recovered, and is still being recovered, from DOE uranium-enrichment plants. While the Department has not released this material for unrestricted recycling, it has not decided on a final course of action for ultimate disposition of the nickel. After initial evaluation, DOE has determined that a suitable application for the

nickel could involve the fabrication of waste containers or related components for a high-level radioactive waste repository or some other disposal facility.

7.1.4 (9391)
Comment - EIS001888 / 0096
DOE's selections of corrosion rate values for the waste-package Corrosion Allowance Material (A516 10,01 carbon steel) may not adequately represent the corrosion-rate potential because they do not account for the effects of drip velocity, and formation of salts and chlorides. Similarly, the corrosion rates for the 7.0 Corrosion Resistant Material, Alloy 22, may not adequately account for adverse crevice-corrosion conditions. Corrosion rates are discussed in Attachment B.

Response
The evolving design of the engineered-barrier system, as described in the Supplement to the Draft EIS (released for public review in May 2001) and carried forward to the Final EIS, now includes a more robust and corrosion-resistant waste package with a nickel-based alloy (Alloy-22) as the corrosion-resistant barrier over a stainless-steel structural inner liner. In addition, the engineered barrier now includes a titanium drip shield above each waste package for defense-in-depth against corrosion.

The Supplement evaluates the enhanced waste package and explains the rationale for the changes. The degradation model used for predicting long-term performance of the waste packages includes corrosion rates that address salt and chloride formation and adverse crevice corrosion. DOE does not view drip velocity as a meaningful parameter in the long-term performance calculations because the titanium drip shield would prevent dripping on the waste package in the near term and because the analysis assumed that the drift would collapse over time. The EIS degradation model evaluated both drip and no-drip models, as discussed in Appendix I and its referenced sources.

7.1.4 (10279)
Comment - EIS000993 / 0003
I'd like to touch on an issue that is often cited as a failure of spent fuel management performance and NRC [Nuclear Regulatory Commission] oversight. It is the issue of the flawed cask loaded and in operation at Palisades during my tenure. Although we found and reported this partial through wall flaw on a storage container, the NRC demanded that we demonstrate that the cask met all design conditions including the worst case postulated accidents. We were able to demonstrate that it did to the NRC's satisfaction and the cask has been in operation cooling and shielding the spent fuel since 1994 with no abnormal radiation, contamination or any other performance issues. If you don't believe my statement here, I invite anyone to come to MI [Michigan] to stand with me next to the flawed cask and observe for yourself the actual performance and review our historical records. The NRC demanded the cask meet requirements or it could not have been allowed to stay in operation. All future spent nuclear fuel storage and transportation activities must and will meet the same type of standard or they will not be allowed to occur.

Response
The casks that DOE would use to transport and dispose of spent nuclear fuel and high-level radioactive waste at a repository at Yucca Mountain would meet all applicable standards.

7.1.5 DISPOSAL

7.1.5 (1547)
Comment - EIS000357 / 0006
Page 1-6. 1.2.2. The text reads, Cladding. If it is not damaged or corroded, has the capability to isolate the spent nuclear fuel and delay the release of radionuclides to the environment for long periods. What is a "long period"? This is not quantified.

Response
The purpose of this statement is to provide a general sense that the zirconium alloy cladding that encases most of the commercial spent nuclear fuel would provide an isolation barrier for thousands of years. The improved cladding degradation models used for the analyses in the Final EIS indicate that less than 10 percent of the cladding would be perforated at 50,000 years, and that about 15 percent would be perforated after 100,000 years (DIRS 157307-BSC 2001).

7.1.5 (4873)
Comment - EIS000337 / 0011
Pg. 2-61, Section 2.2.2.1: Storage Packages and Facilities at Commercial and DOE Sites, 4th par.: "Figure 2-38 shows a typical dry storage canister,...." Are these canisters the same as what will be used in the proposed action? If not, why not?

Response
The dry storage canister depicted in Figure 2-34 of the EIS is typical of canisters in use today to store spent nuclear fuel in a dry configuration at commercial nuclear reactor sites and some DOE facilities. Canisters of spent nuclear fuel that utilities store on site in a dry storage cask would resemble the canister shown in Figure 2-34. The decision to place fuel in such a configuration, however, is made by the utilities, not DOE.

The Proposed Action includes removing the spent nuclear fuel from these commercial and DOE sites and transporting it to Yucca Mountain for emplacement in a repository. At Yucca Mountain the spent nuclear fuel and high-level radioactive waste would be placed in specially designed waste packages for emplacement in the repository. The function of the waste package would change over the lifetime of the repository. During the operation and monitoring phase, the waste packages would function as the vessels for safely handling, emplacing, and retrieving (if necessary) their contents. After closure, the waste packages would be the primary engineered barrier to inhibit the release of radioactive material to the environment.

The function of the repository's waste packages is similar to the function of short-term dry storage canisters used at utilities. However, the repository's waste packages are also designed specifically for the long-term needs of permanent disposal.

7.1.5 (4882)
Comment - EIS000337 / 0022
Pg. 5-28, 1st par, last sentence: Until now DOE has stated that it is difficult to obtain precise values. This section discussed juvenile failures and made the ambiguous statement that they would be very low. DOE proceeded to say that if there were no failures the mean consequences would decrease by 2%. They have not proven that anything in this DEIS is accurate to 2%.

Response
For the purposes of analysis in the Draft EIS, DOE assumed that 1 of every 10,000 waste packages would fail completely, exposing all its contents 1,000 years after closure of the repository. This rate was based on industrial experience of manufacturing and handling (DIRS 101779-DOE 1998). The statement that the mean consequences would decrease by 2 percent in the event of zero juvenile failures means that the repository system would still provide excellent isolation of the waste, even in the event of juvenile failures.

As part of the waste package performance analysis performed for the updated package design for the flexible design, DOE conducted a comprehensive evaluation of fabrication processes. The results of the analysis indicated that improper heat treatment could result in early failure of some packages. The results showed that the probability of an improperly heat-treated waste package in the proposed repository was 20.2 percent. Corresponding probabilities for two and three improperly heat-treated packages were 2.6 percent and 0.2 percent, respectively. (DIRS 155950-BSC 2001). The Total System Performance Assessment Model was run with these probabilities sampled, so that a little more than 20 percent of the simulations show a very small release prior to 10,000 years as a result of these early failures. The resultant annual doses are many thousand times smaller than the limit in the Environmental Protection Agency standard. A strong quality assurance program would ensure proper fabrication, stress relief, and testing of the waste packages before emplacement.

In addition, the updated waste package modeling and life expectancies for the flexible design evaluated in the Final EIS are based on experiments and analyses documented in the *Waste Package Degradation Process Model Report* (DIRS 151624-CRWMS M&O 2000) and the *FY 01 Supplemental Science and Performance Analyses Report* (DIRS 154659- and 155950-BSC 2001). These studies identify and discuss each potential waste package degradation mode. The degradation model includes those modes that analyses did not screen out as highly improbable.

Obviously, there is uncertainty associated with the extrapolation of experimental results for such long periods. DOE selected the design analyzed in the Final EIS to mitigate the uncertainties by adding features (such as the drip shield) to provide defense-in-depth. This provides greater assurance that the repository would meet its performance standards in the face of uncertainty.

7.1.5 (7291)
Comment - EIS001683 / 0002
There are so many reasons why nuclear waste should not be stored at Yucca Mountain. The casks are not able to contain the waste. Bacteria found at the site can corrode them.

Response
The Yucca Mountain repository, as described in the May 2001 Supplement to the Draft EIS, includes a robust engineered barrier system designed specifically to work with the favorable natural-barrier system at Yucca Mountain. The container in which DOE would place nuclear waste in the repository would not be the sole engineered barrier. The current design includes a robust waste package with a nickel-base alloy (Alloy-22) as the outer corrosion-resistant barrier over a stainless-steel structural inner liner.

DOE is evaluating waste package materials, including Alloy-22, for reaction to an attack by microbes under conditions expected at Yucca Mountain. To date, this evaluation has identified no bacteria-related concerns for Alloy-22. However, for conservatism, DOE added a microbial attack factor to the assessment of the long-term performance of Alloy-22. Information in the Supplement, carried forward to the Final EIS, evaluates the new design and materials for waste packages and explains the rationale for the enhancements.

7.2 Repository Operational Plans

7.2 (1704)
Comment - EIS000624 / 0002
I have been told by many of them people there, if [an] accident ever happens out there, we're going to get the robots out here from back east, two of the robots. They are going to handle it. I think that's under no agreement, or I don't know what you call it. Let's all think about it. What are we going to do if accident ever happens?

Response
Section 4.1.8 of the EIS describes potential accident scenarios. In the event of a radiological accident, DOE would use remotely controlled equipment such as inclined plane haulers, load-haul-dumps, and other special equipment to recover from such accidents. This equipment exists today. DOE has identified and developed the methods for retrieval and the equipment and procedures it would use for retrieval under both normal and abnormal conditions. The Department would not rely on "robots" or any other technology strictly from one source or location.

Tables 2-7 of the EIS compares the potential accident consequences for the Proposed Action and No-Action Alternative. Appendix H contains a more detailed discussion.

7.2 (5327)
Comment - EIS001887 / 0055
Page 1-17; Section 1.4.2 - Proposed Disposal Approach

The third sentence of the first full paragraph indicates that "(t)he waste packages would be moved underground by rail." This is also described elsewhere in the document (Section 2.1.2.2.1 Subsurface Facility Design and Construction, Page 2-27 through 2-31). However, nowhere does the Draft EIS indicate what level of inspection will be performed on the rail/trolley system, as well as other infrastructure in place at the site. Inasmuch as a transportation or emplacement related accident at the site could have catastrophic and long-term impacts to Nevada, quality control, inspection by qualified outside expertise, and a comprehensive maintenance and inspection program for the transportation activities and infrastructure within the site are critical to program safety. The Draft EIS fails to address this important component of long-term site safety.